POISONOUS FISHES OF THE SOUTH SEAS

SPECIAL SCIENTIFIC REPORT: FISHERIES No. 25

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

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United States Department of the Interior
Oscar L. Chapman, Secretary
Fish and Wildlife Service
Albert M. Day, Director

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No. 25

POISONOUS FISHES OF THE SOUTH SEAS

Translated from the Japanese language by

W. G. Van Campen

Pacific Oceanic Fishery Investigations

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1/ Nissan Fisheries Experiment Station Odawara Branch

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PREFACE

In June of 1941 I compiled An Illustrated Guide to the Edible Fishes of the South Seas, which was dedicated to the Imperial armed forces by the Nippon Suisan Kabushiki Kaisha as a contribution to the nation by the fishing industry. Now, with the situation becoming more and more serious, I am convinced that it cannot be useless to make even a slight contribution to the solution of the marine food problem in the South by studying the poisonous fishes as well as the edible varieties, and, since I know that the military authorities have been urging preparations along the same lines, I have not been able to resist the desire to comply with their wishes.

When we were entrusted with this investigation by the naval authorities, our pride and emotion were inexpressible. We immediately made all preparations, obtained the cooperation of the Department of Agriculture of Tokyo Imperial University and the Fisheries Experiment Station of the South Seas Office, and despatched Yoshio Hiyama (on leave from his assistant professorship at Tokyo Imperial University), Tanzō Nishisawa (technician at the Fisheries Experiment Station of the South Seas Office), Tomoharu Murofushi (temporarily assigned), and Shigeru Arita (temporarily assigned) to conduct the investigation in the field from July to December, 1941.

Our research team, overcoming unforeseen difficulties and inconveniences, visited various South Sea Islands insofar as available transportation facilities permitted, and after in general attaining their objectives all returned safely on December 4 with the precious material which they had assembled. Only four days later the war broke out and the declaration of war was promulgated, which can only be regarded as a miracle of divine providence.

Thereafter we busied ourselves in organizing and compiling our data, and were able to gain a knowledge of the general situation with regard to poisonous fishes of the South Seas. In June of the following year (1942) we compiled an illustrated guide to poisonous fishes to be used as a ready reference in the South Seas, particularly in the areas in which the Imperial forces were operating. Mr. Yoshio Hiyama had further advanced the work of compilation to assemble the present detailed report of the whole picture of the investigation of poisonous fishes of the South Seas. Feeling that this report was timely and should have a wide circulation, we have obtained the [Page 2a] permission of the authorities to publish it.

The work of compilation and editing has been greatly assisted by the ardent labors of Messrs. Shigeru Muramatsu, Tadashi Kumada, Takeo Funada, Fukuzō Katano, and Mesdames Kikue Tomita and Hatsue Sasaki.

This report is, of course, not to be considered as final, and we expect to carry on further researches at present and in the future.

Finally, we wish to acknowledge with gratitude the unfailing support and guidance of the naval authorities, the South Seas Office, the Department of Agriculture of Tokyo Imperial University, and various persons in the areas visited. If this report makes our slight efforts of any value to persons active in the South, it can only be due to the aforementioned understanding support and wise guidance.

February 28, 1943

Toshiro Kumada

[Page 1] CHAPTER I

Introductory

Section 1 Introduction

Hitherto the poisonous fishes of the South Seas have been little known, probably because those seas are remarkably rich in useful marine resources which could fill the need for food without the necessity of trying to bring every different species to the table. For this reason fisheries research organizations and researchers both in the South Seas and in Japan have concentrated on studies of the useful species. As a result many advances have been made in this field, but on the other hand there have naturally not been any worthwhile studies made of the so-called "reef fishes", whose food value is small.

Furthermore, the poisonous fishes which are the object of this report are not found in great numbers anywhere in the South Seas, and they are most plentiful in far places where few Japanese venture, and where not only are research facilities completely lacking but where heat and [Page 2] disease make merely existing difficult for those who work with their brains. This is another reason for the lack of knowledge about poisonous fish.

In spite of this, two or three pioneers have already pursued studies in this field, and, as set forth in a later section, some of their reports are worthy of note. The writer, before sailing, tried to examine the whole situation regarding poisonous fishes in the South Seas by consulting these authorities and also by communication with persons in the various areas, however, in most cases the information about the fish themselves was inadequate and it proved impossible to grasp the true situation.

The author, after going to the islands, made various inquiries of fishermen, natives, and others. Although there were some among them who gave a true picture of things, most of them supplied strange stories which clashed with common sense, or else the information they supplied had already been recorded in the previous literature. Coming to know the complexity and strangeness of the problem, the author felt on the one hand an interest in trying to clarify it, and on the other hand he lost confidence in being able, with his poor powers, to accomplish the task. Fortunately, through the support of many persons, we have finally arrived at the reporting of our results, but given a problem of such complexity, in such a short space of time and with preparations, facilities, and personnel far from ideal, we have not been able completely to solve it. This report is incomplete in many respects and we can only trust that it will prove valuable in encouraging later researches.

The main objective of this investigation has been to carry out the most practical kinds of studies and experiments to ascertain what kinds of fish are poisonous, how ordinary methods of preparation for the table affect their toxicity, and, if possible, how to eliminate the poison and

treat cases of poisoning. The author had hoped to attempt more detailed studies, but these were of secondary importance and the pressure of time has made it impossible to get around to them.

However, if the work reported herein has in general attained the hoped-for goal of a practical experimental study, if it can be said to have attained results which can be used without serious error in the areas studied and in other neighboring areas of the South Seas, and if this report is of any benefit to the world, it is due to all those who conferred their support and assistance, and we here express our deep thanks to them.

[Page 3] Section 2 Past Studies of Poisonous Fish*

First we will consider the term "poisonous fish". The species of fish which harm man are not few. Among them those whose bodies contain poisons which are transferred to the human body should be called poisonous fish. However, there are various methods of accomplishing this. One is to transmit the poison by biting, another is by sticking with spines, and a third is by being eaten by humans. The first should be called "venomous fish", and the second "poison-spined fish". Although the third type could be called "fish which are poisonous when eaten", in this report they will be referred to simply as "poisonous fish", using the term in this restricted sense.

This study has been mainly concerned with the species which cause poisoning when eaten by human beings, but because of practical considerations it also touches upon some of the "poison-spined fish".

The most comprehensive report upon poisonous fish in the broad sense is that of the German Pawlowsky** (1927). In this paper the author collected all references to poison in the literature and classified them as venomous, poison-spined, and poisonous when eaten. As many as 61 species are listed as poisonous when eaten, but among them are mixed some which are clearly of the type which poison by piercing and it is believed that the number of those which are truly poisonous to eat should be somewhat reduced.

These are here classified and listed. The habitat is in parentheses; the scientific name is reproduced as given.

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*After completing the manuscript of this report the author learned of the publication by Lt. Kawakubo (M.C.) IJN and Lt. (j.g.) Kikuchi (M.C.) IJN of a paper entitled Animal Experiments with Poisoning by Poisonous Fish of the South Seas and an Example of Fish Poisoning (Naval Medical Society Journal, Vol. 31, No. 8, August 1942). These officers made an animal experiment using the jab and pan of Jaluit(see pp. 43, 45 of this report) and reported approximately the same results as this report.

**Pawlowsky, E. N.: Gifttiere 1927, Jena.

Cyclostomata (Petromyzontia, Myxinoidea)

Petromyzon marinus Linné (Baltic Sea)
Caspiomyzon wagneri Kessler (Caspian Sea and its rivers)
Lampetra fluviatilis Linné (Central Europe)
Lampetra planeri (Bloch) (Baltic, Dnieper, Don)
Slime secreted by the skin said to be poisonous.
Caused poisoning in soup at Petrograd.

Elasmobranchs (sharks and rays)

Carcharias glaucus Linné — liver
Galeus canis Bonapart — liver

[Page 4]

Notidanus (Hexanchus) griseus
Scyllium canicula Cuvier

Lamellibranchs

Serranidae

Serranus rupestris
Serranus louti (Pomotous [sic] Is.)
Serranus ouatabuli — Antillen
Serranus creolus — Antillen

Mesoprion cynodon C. & V. (Antillen)
Mesoprion jocu C. & V. (Havanna)

Chaetodontidae

Chaetodon sp. (Red Sea to Polynesia)

Sparidae

Pagellus calamus (Jamaica)
Pagellus erythrinus (Moreau de fonnes)
Sparus pagrus (case of poisoning aboard the "Resolution" at Mallicola)
Lethrinus rostratus
Lethrinus mambo. Cases of poisoning aboard the "Infernal" at Ile des Pins, Lamotte-Piquet (New Caledonia). Small fish (13-14 cm.) did not cause poisoning, large fish (80 cm.) did.

Carangidae

Caranx fallax (Havanna)
Caranx plumieri
Seriola gigas (Havanna)
Seriola lalandi (Havanna)

Coryphaenidae

Coryphaena hippurus
Coryphaena dorado (Jamaica)
Coryphaena coerulea (Granada)

[Page 5]

Cybiidae

Cybium caballa (Havanna)

Cybium acervum
Malte vespertilio

Gobiidae
Gobius criniger C. & V. (Pondischeri)

Sphyraenidae
Sphyraena picuda
Sphyraena becuna (American tropics and subtropics)
Sphyraena barracuda

Tetragonurus cuvieri
Scarus sp.
Pseudoscarus sp.

Anacanthini
Lota vulgaris
Rhombus laevis

Siluridae
Silurus bagrus
Silurus militaris
Bagrus aurantiacus
Silurus japonicus (Japanese catfish called poisonous by Siebold; perhaps referred to poison spines)

Cyprinidae and others
Barbus barbus (Central and Southern Europe, Dnieper, Volga (ovaries poisonous in the Kuban, Caucasus, and in Turkistan)
Schizothorax intermedius ovaries
Tinca vulgaris ovaries
Abramis brama ovaries
Lebias calarinata (Sumatra)
[Page 6] *Cyprinodon calarinatus* C. & V. flesh

Belonidae
Belone acus (Mittelmeer)
Belone brasiliensis
Belone marginata
Belone caribaea

Esocidae
Esox lucius ovaries

Clupeidae
Clupea ilsha poisonous only in spawning season
Clupea thrissa (Tahiti)
Clupea (Meletta) venenosa (Indian Ocean)
Meletta thrissa
Spratella fimbriata (Malabar)

Apodes
- Muraena helena
- Anguilla spp. — blood, poison called Ichthyotoxine
- Conger spp.

In addition a large number of tetraodonts are cited, and several species are listed as containing protamine.

Another study of poisonous fishes of the South Seas is that made at Saipan by Dr. Takashi Yasukawa of the Contagious Disease Research Station.* He concluded that the toxic agent is not bacterial. His report gives only the local names of the species but the present author has added the scientific names and the standard [common] names used in this report, as follows:

Local name	Scientific name	Japanese common name
akamasu	Lutjanus spp.	akadokutarumi, etc.
ōmachi	Aprion virescens	aona
ōhiraaji	Caranx melampygus	dokuhiraaji
unagi (utsubo)	Gymnothorax spp.	dokuutsubo, etc.
Page 7 okamasu	Sphyraena picuda	dokukamasu
ōmebaru	Serranus spp.	hata
kuchiku	Ctenochaetus strigosus	sazanamihagi
fugu	Tetraodon spp.	fugu

Another report was made by Ryūichi Matsuo, Medical Officer of the South Seas Office, of a study of poisonous fish at Jaluit in 1934.** Of 180 species found at that atoll, he listed 36 as poisonous, recording them by their native names. The present author has supplied the scientific names and Japanese common names for these species as follows:

Native name	Scientific name	Japanese name
1. aél	Hepatus olivaceus	montsukihagi
2. aujbak	Synodus variegatus	akaeso
3. deb	Gymnothorax sp.	a kind of utsubo
4. hö	Pterois volitans	minokasago
5. holeketem bub	Balistes sp.	a kind of mongarahagi
6. ikbij	Caranx lessonii	niramihiraaji
7. ikuit	Epinephelus leopardus	hiodoshihata
8. illinno	Serranus microdon	iwahata
9. jab	Lutjanus sp.	fuedokutarumi
10. jalia	Lethrinus miniatus	kitsunekuchibi
11. jarerwód	Lutjanus sp.	a kind of fuedai
12. jawe ėlik		a kind of hata

*Yasukawa, Takashi: Report of an Investigation of Poisonous Fish of the South Seas, South Seas Office, 1934. Mimeographed.

**Matsuo, Ryūichi, Report of an Investigation of Poisonous Fishes at Jaluit I., in Collected Medical Reports on Endemic Diseases of the South Sea Islands, Second Edition, p. 309-326, July 1934. Published by the South Seas Office.

13.	jebeb pako	Sphyrna zygaena	shumokuzame
14.	jidjidbeiu	Lethrinus sp.	a kind of kuchibitai
15.	jollol	Cheilinus fasciatus	yashabera
16.	jomme		a kind of himeji
17.	jone pako		a kind of same
18.	jujukeb	Sphyraena picuda	dokukamasu
19.	jula	Plectropomus oligacanthus	amadaredokuhata
[Page 8]			
20.	jurre	Sphyraena forsteri	omekamasu
21.	katok	Lethrinus sp.	a kind of kuchibitai
22.	kielolan	Monotaxis grandoculis	dokudai
23.	kolaolap		a kind of hata
24.	labbo elik	Cheilinus sp.	hanabibera
25.	lane	Caranx melampygus	dokuhiraaji
26.	lemejne	Lethrinus sp.	usugumokuchibi
27.	mameni	Lethrinus sp.	usugumokuchibi
28.	manid		hata family
29.	no	Scorpaenopsis diabolus	sepparikoze
30.	pan inar	Lutjanus bohar	futatsuboshidokugyo
31.	petwetak	Lutjanus fulviflamma	nise kurohoshitarumi
32.	poran		a kind of ei
33.	tiebedo	Ctenochaetus strigosus	sazanamihagi
34.	tinad	Gnathodentex aurolineatus	nokogiridai
35.	weo elap	Lethrinus sp.	oakakuchibi
36.	wat	Tetraodon sp.	a kind of fugu

Of these thirty-six species over half have been caught and tested by the author, and some observations have been made concerning the others (Chapter II, Section 12).

Mr. Hisatoshi Marukawa has also abstracted the above two papers in Fisheries of the South Sea Islands from the Oceanographical Point of View in the eighth edition of South Seas Fisheries Papers published by the South Seas Fisheries Association, May 1940.

Mr. Takeo Otani has also published extracts from them in The Science of Conchology.

There are many studies of poisonous tetraodonts of Japan proper by Takahashi, the Idas, Tahara, Fukuda, Inoue, the Kinoshitas, Ishihara, Iwagawa, the Kimuras, and others.

There are also some studies by Prof. Jun Yamakawa and others on species of fish which contain protamine.

The above are the studies of species which cause poisoning when eaten; on fish with poisonous spines there is a Japanese paper by Prof. Ikusaku Ameniya on the poison gland of the aigo [Siganus fuscescens (Houttuyn)] and numerous other foreign papers.*

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*Ameniya, Ikusaku: On the Structure of the Poison Spines of the Aigo. Suisan Gakkai Ho, Vol. 3, p. 196.

[Page 9]

The author's investigations and experiments are concerned with the Marianas and Marshalls areas. The investigation touched upon other areas, but experiments involving collecting were limited to Saipan in the Marianas and Jaluit in the Marshalls.

Broad inquiries were made concerning poisonous fish among fishermen, natives, and fisheries technologists in these areas. Testimony was taken from those who had had experience with cases of fish poisoning and from medical officers in the areas.

In addition efforts were made to collect fishes by various methods. The chief method used was driving fish into a net, but angling, long lines, trawls, and underwater spearing were also resorted to. Great numbers of fish were taken by the use of explosives.

Since the number of species taken was so very great, it was impossible to test them all, so from them we chose for our experiments those which had been reported either by informants or in the literature as poisonous and those which so closely resembled the reportedly poisonoua species as to be easily mistaken for them. Tests were also made on all species which appeared promising as food fish by reason of their large size and the large numbers taken.

The fish caught were taken immediately to the laboratory where the fresh coloration was recorded in drawings as rapidly as possible. The fish were then preserved in formalin and later taken to Japan where photographs were made. The plates for this book were made by taking the outline of the fish from the photographs, and adding the coloration recorded in the sketches made in the field.

On fish intended for experimentation, an effort was made to record accurately the time of capture in order to indicate the degree of freshness.

Materials used in experiments with animals were, in order to simulate real conditions, prepared as if actually for table use, as described below. A knife was inserted in the belly of the fish and the flesh was removed from one side, taking care not to damage the viscera, and this fillet was divided so as to give representation to all parts insofar as possible. The blood, liver, ovaries, testes, and other viscera were likewise divided. Portions of fresh muscle tissues were set aside for testing, and cooked portions were prepared. These are referred to hereafter as "fresh tissue" and "cooked tissue". In cooking, the tissue was placed in a covered alumite cooker with an equal quantity of water and heated over an alcohol lamp for from 5 to 20 minutes until the fluid in the vessel was almost gone after which it was removed from the fire. Then test portions of approximately equal weight with the test portions of fresh tissue were prepared. In one or two cases salted and dried test portions were also prepared. Blood was [Page 10] mixed with starch (tapioca starch) or refined fishmeal in a milk bowl and weighed.

Mice were chiefly used as experimental animals. Cats were also used as much as possible, and some puppies were used.

The test material was given by mouth in almost all cases. The mice were kept without food for approximately 24 hours before the test. The test material, prepared as described above, was presented to the animal in a watch glass. After several hours it was removed and the leftover portion was measured. Feces and other extraneous materials were removed and portions of the fish which had been scattered about by the animal's feet were carefully gathered up. In addition, portions of the same material were left for the same period of time and the loss by evaporation was measured in order to provide data for correcting the weights of material under similar conditions. In the tables of animal experiments, "amount eaten" represents the difference between the amount given and the remainder. Materials added (blood, liver) and the amount of evaporation should be subtracted from this figure.

In the case of the cats and puppies it was not as necessary to starve them beforehand as it was with the mice, and they readily consumed up to 50 grams of material.

The mice were ordinarily kept on a diet consisting chiefly of polished rice and cracked rice with vegetables added. When vegetables were unobtainable, leaves of the ginnemu and fresh copra were substituted. The cats were kept in baskets at first but it proved difficult to keep them and many died so finally a cage enclosing about six and one-half square meters of ground was constructed and about 30 cats were kept in it. About 500 mice were transported by air to the scene of operations. Ten cats were flown in but only about one-third of them arrived in a healthy condition. At Jaluit local cats were obtained whenever possible, about 50 being utilized.

In evaluating the effect of a feeding on the mice, in case they did not die, it was found to be difficult to determine a light degree or the early stages of poisoning. For this reason the early experiments produced no trustworthy data. As experience was gained it was found possible to determine a slight degree of sensory impairment by lightly pricking the paws, lips, and back with a dissecting needle and observing the reaction. In the case of the cat the same technique had to be employed with animals affected to only a very slight degree, but with those somewhat more strongly affected, it was generally possible to detect the condition immediately by making them walk. Animals which were poisoned began to stagger right away, and if the poisoning was a little more severe, they could not hold their bodies in position to walk and fell frequently. In the most severe cases they only tried to lie down and made no attempt to raise themselves. We tried insofar as possible to follow a policy of not using the same animal twice for experiments, but because of the shortage of animals [Page 11] some of the cats which recovered were used again after two or three days.

Because the author was requested to make the animal experiments simulate real conditions; they were all made by feeding the test materials to the animals, however; this method depends on the amount eaten by the animal and therefore, as is shown in a later section of this report, it is

not possible in many cases to determine as accurately as one would like the strength of the poison. If anyone might wish to carry on further experiments of this sort, the author recommends the use of injections by the extraction method described in a later chapter.

The following facts should be noted with regard to the tables of animal experiments inserted in the various sections of this report:

(1) Experimental animal. M is the abbreviation for "mouse". No. is the number of the cage. The cages were divided into two compartments and the animal used in an experiment is designated as "right" or "left". The mice were not given individual serial numbers and for this reason when the two mice in one cage were used in different experiments the cage number is the same. The cats were not given serial numbers except for temporary ones assigned when a large number of animals were being kept at one time. Animals for which no body weights are recorded are those for which the data were lost, and for these the weights run about 10-20 grams for the mice and 500 grams — 1 kilogram for the cats.

(2) The figure on the line below the individual serial number of a fish indicates the total length.

(3) The ratios of mixtures where fishmeal, starch, and so forth were mixed with the test material is shown as 1:1 or as $\frac{1+1+1}{3}$. The true quantity should be determined by subtracting the amount of material added.

(4) "Flesh", "head", "tail", and so forth indicate muscle tissue taken from those parts.

(5) "Fresh" (or "raw") or "cooked" indicate respectively unprepared material and material prepared as described above.

(6) Amount of evaporation has not been subtracted from the amount eaten. As a standard for determining this correction the time at which the remaining food was weighed has been recorded. Time was lacking to make these calculations for each experiment, but the following examples are given to serve as a reference for evaluating the data of all the experiments. These measurements were made in the laboratory at Saipan.

Date	Fish	Test Material	Time Offered	Time Remainder Weighed	Amount Offered	Re-mainder	Elapsed Time	Amount of Evaporation
9 - 11	Sazanamihagi [*Ctenochaetus strigosus*]	Fresh flesh	1530	0900	2gr	1.5gr	17 hr. 30 min.	-0.5gr
"	"	Cooked flesh	"	"	"	1.4gr	"	-0.6gr
9 - 17	"	Fresh flesh	1040	1700	1.5gr	0.5gr	30 hr. 20 min.	-1.0gr
"	"	"	"	"	"	0.7gr	"	-0.8gr
"	"	Cooked flesh	"	"	2gr	0.8gr	"	-1.2gr
"	Yodarehata [*Serranus sp.*]	Liver & meal	"	"	$1\frac{1}{2}$ gr	0.8gr	"	-0.2gr
9 - 18	Yogcrefugu [*Tetraodon nigropunctatus*]	Blood & meal	1500	1600	$1\frac{1}{2}$ gr	0.5gr	1 hr.	-0.5gr

The author while in Japan had heard of cases of fish poisoning and had wondered whether, in view of the high temperatures prevailing in the South Seas and the insufficient refrigeration facilities available there, they might not be due to putrefaction. For this reason it was deemed necessary to begin by clarifying the relationship between putrefaction and toxicity. Six species generally considered poisonous were chosen and tested by being fed to mice after having been left for some time at atmospheric temperature. The results were as follows:

I. Species - dokuhiraaji, Caranx melampygus Cuvier & Valenciennes.
Time caught - August 25 at 0900

(1) 10 hrs. 15 min. at 28° C
Muscle tissue softened, pH 6.1. Blood (0.6–0.3 gr), liver (0.6–0.0gr), ovary (1.5–0.0 gr), and muscle (1.2–0.0gr) were each fed to 10 mice, a total of 40 animals (body weight 15 gr). In no case was there any observable effect.

(2) 15 hrs. Omin
Muscle tissue softened, no odor of putrefaction, pH 6.3. One cat was fed 44 gr of cooked muscle tissue, and another was given 52.5 gr of raw flesh (body weight of cats about 1.5 kg). The cat which ate the raw flesh showed no ill effects. The cat which ate the cooked flesh regurgitated almost all of it but showed no other ill effects.

(3) 19 hrs. 30 min. at 27° C
Muscle tissue softened, slight odor of putrefaction, pH 6.2. Muscle tissue (2.0–0.6 gr) was fed to ten mice. No ill effects observed. The viscera stank badly and the mice would not eat them.

II. Species - kitsunekuchibi (Lethrinus miniatus Schneider)
Time caught - August 25 at 0900

(1) Tested at 1108
Muscle tissues in rigor mortis. pH 6.2. Blood (0.5 gr, 0.4 gr, 0.4 gr, 0.3 gr, one did not eat), gall (0.6 gr, 0.6 gr, 0.5 gr, 0.5 gr, 0.4 gr, 0.4 gr, [sic] , liver (0.4 gr, 0.4 gr, 0.3 gr, 0.1 gr, one did not eat), ovary (1.2 gr, 1.0 gr, 0.5 gr, 0.4 gr, 0.2 gr), and muscle tissue (2.5, 2.4, 2.1, one did not eat) were each fed to five mice with no ill effects noted.

(2) 15 hrs. at 28° C
[Page 13] Muscles softened. No putrefactive odor, pH 6.4. One cat was fed 37.2 gr of raw flesh and another was fed 54.1 gr of cooked flesh (body weight of cats 1.5 kg). The raw flesh caused no ill effects, the cooked flesh was all regurgitated but caused no other ill effects.

(3) 19 hrs. 30 min. at 27° C
Muscles softened, slight odor of putrefaction. pH 6.2. Seven mice (body weight 15 gr) were fed muscle tissue (2.6 gr, 2.3 gr, 1.8 gr, 1.8 gr, 1.7 gr, 1.6 gr, 1.0 gr). One developed diarrhea, no other ill effects were observed.

III. Species - akadokutarumi, Lutjanus vaigiensis
Time caught - August 26 at 0910
(1) Tested at 1118
Muscles soft, pH 6.6. Blood (0.5 gr, 0.3 gr, 0.3 gr), liver (0.5 gr, 0.5 gr, 0.4 gr), raw muscle tissue (0.9 gr, 0.2 gr, 0.2 gr), and cooked muscle tissue (2.7, 2.7, 2.0) were each fed to three mice (15 gr). No ill effects were seen.

(2) Tested at 1938
Muscles soft, slight odor. Raw muscle tissue (2.4 gr, 1.8 gr, 1.8 gr) and cooked muscle tissue (5.0 gr, 4.7 gr, 4.4 gr) were each fed to three mice (15 gr). No ill effects.

The above are the results of the experiments. In all experiments with mice, no symptoms of poisoning were found, regardless of the degree of freshness of the fish. In each experiment with cats the cooked test material was regurgitated, but the raw flesh was eaten without ill effects. However, at the time of these experiments, we did not have sufficient background knowledge of the effects produced by fish poisoning and did not suspect that it might give rise to sensory impairment, and so unfortunately we did not test to determine the presence of such impairment. It is also to be regretted that the species used were not strongly toxic ones. It can be said, nevertheless, that none of the animals died as they did in some later experiments, and that the poison therefore does not result from decomposition.

An examination of examples of fish poisoning in humans shows that of 11 cases reported at Saipan, two occurred about two hours after the fish were caught, one about three hours after, and the other eight within one hour of the time of capture. Two cases reported from the Marshalls both occurred directly after the fish were taken. The species were dokuhiraaji, dokufuedai, dokuutsubo, akaganmo, and dokukamasu. (For the Japanese common names, see the following chapter.)
[Page 14]

In regard to the freshness of market fish, it is necessary to consider the fish supply situation in the area studied. Ordinarily, early in the morning a fleet of canoes goes to the nearby outer reef where they operate driving-in nets [oikomiami], returning around noon or in the evening. The catch is immediately sold at a market near the beach or at the fishermen's homes. Fish brought in around noon are eaten at the noon meal while those brought in late in the afternoon are used for the evening meal. Where there are proper facilities, any remaining fish are made into fishcake [kamaboko or chikuwa]. Fish are never held overnight for sale

the next day. The towns which are centers of fish consumption are everywhere near the coast, and even when the fish are sent to another place, little time is required for transportation because the islands are small. Even in islands where refrigeration facilities are limited or entirely lacking, it is difficult to see how many cases of poisoning could result from putrefaction because the fish are used in a fresh condition. These facts back up the results of the experiments recorded above, and cases of poisoning resulting from putrefaction in the high temperatures of the South Seas must be considered as a separate phenomenon.

[Page 15] CHAPTER II

Species of Poisonous Fish and Their Toxicity

Section 1 General

This chapter is an attempt to record not only all of the poisonous and nonpoisonous varieties tested by the author in person, but also all which have been recorded in the literature or which were reported by fishermen and natives to be poisonous but which could not be caught or which were taken when conditions prevented testing them.

Many of the varieties reported on could not be identified with certainty because specimens could not be obtained and the local names and inadequate descriptions were all we had to go on. Also, some of them could only be considered as fish with poisonous spines and these are all taken up in Section 12.

In the case of varieties which were accurately identified either by descriptions or by catching specimens but which could not be tested, we have recorded in this chapter all testimony received regarding their toxicity, in order to serve as a basis for judging its comparative strength.

The following table gives all the species which can be considered poisonous as a result of this study. The taxonomic relationships between these many species are interesting. They fall into a number of taxonomic groupings and are not scattered at random taxonomically. In other words, poisonous fish only occur in certain families and certain genera. This is just the same situation that is found in Japan where the poisonous fishes are limited to the _Tetraodontidae_ and even to the genus _Tetraodon_.

Looking at the Class Pisces as a whole, we find that of its hundreds of families, only twelve include poisonous fish. Considered from the point of view of species, authorities differ, but the number of species in the Class is between ten and thirty thousand, and the number of poisonous species, including not only those considered in this investigation but also those found in foreign countries, does not come up to one hundred. Fish which cause poisoning when eaten are only a very few species, considering fish as a whole, and they belong to a very few taxonomic divisions.

[Pages 16 and 17] Reference table of poisonous fish (45 species, tetraodonts omitted)

[Page 18]
It should be noted that this is not to say that all of the fish in these families and genera are poisonous. They also contain edible species which are completely nonpoisonous.

The following sections are organized according to the taxonomic divisions.

Reference Table of Poisonous Fish (45 species, tetraodonts omitted)

Japanese name	Scientific name	Family	Local name	Toxicity	Plate No.
dokuutsubo	<u>Gymnothorax</u> <u>flavimarginathus</u> Rüppell	Muraenidae	drĕb (Marshallese), jaunagi (Japanese), gomautsubo (Japanese dialect)	violent	1
shiromon dokuutsubo	<u>Gymnothorax</u> <u>meleagris</u> Shaw	"	dreb (Marshallese), jaunagi (Japanese), hanabiutsubo (Japanese dialect)	violent	1
namiutsubo	<u>Gymnothorax</u> <u>undulatus</u> (Lacépède)	"	dreb (Marshallese)	strong	1
amadare-dokuutsubo	<u>Gymnothorax</u> <u>undulatus</u> var. isingteenus (Richardson)	"	maj (Marshallese)	said to be nonpoisonous	2
aseutsubo	<u>Gymnothorax</u> <u>pictus</u> Ahl	"	dreb (Marshallese) jaunagi (Japanese)	said to be poisonous	2
shiroutsubo	<u>Gymnothorax</u> <u>thyrsoideus</u> (Richardson)	"	maj (Marshallese)	said to be nonpoisonous	2
dokukamasu	<u>Sphyraena</u> <u>picuda</u> Bloch & Schneider	Sphyraenidae	kamasu, kamasa, shikiru kamasa (Japanese) jujukob (Marshallese)	violent	3
ōmekamasu	<u>Sphyraena</u> <u>forsteri</u> Cuvier & Valenciennes	"	jure (Marshallese)	mild	3
dokuhiraaji	<u>Caranx</u> <u>melampygus</u> Cuvier & Valenciennes	Carangidae	lañe (Marshallese) gāra (Okinawan) hirsaji (Japanese)	large ones strong, small ones mild	4
nirami-hiraaji	<u>Caranx</u> <u>lessonii</u> Cuvier & Valenciennes	"	ikubuj (Marshallese) mindanagāra (Okinawan)	large ones strong, small ones nonpoisonous	4

akadoku-tarumi	Lutjanus vaigiensis (Quoy & Gaimard)	Lutjanidae	akamasu (Japanese)	mild	5
futatsu-boshi dokugyo	Lutjanus bohar (Forskål)	"	baan or pan (Marshallese) akamasu (Japanese)	mild	5
fuedoku-tarumi	Lutjanus (Loxolutjanus) sp.	"	jab (Marshallese) fuenamimija (Okinawan)	strong	6
nise kuro-hoshi tarumi	Lutjanus fulviflamma (Forskål)	"	jeblo (Marshallese). Ones with black spots on one side are called botowetak	said to be slight	6
yoitarumi	Lutjanus flavipes (Valenciennes)	"	jaj (Marshallese)	slight	6
yūdachi-tarumi	Lutjanus semicinctus Quoy & Gaimard	"	elikinmi (Marshallese)	slight	7
aona	Aprion virescens Valenciennes	"	aona, aomachi, aomasu, ōmachi (Saipan Japanese), susuki (Marshalls Japanese)	mild	7
kitsune-kuchibi	Lethrinus miniatus (Schneider)	Lethrinidae	jallia (Marshallese) omonaga (Saipan Japanese)	slight	8
variety of kitsune-kuchibi	"	"	roñet (Marshallese)	violent	8
usugumo-kuchibi	Lethrinus sp.	"	mameni (Marshallese)	mild	8
muneaka-kuchibi	Lethrinus variegatus Valenciennes	"	ñet (Marshallese)	strong	9

dokudai	Monotaxis grandoculis (Forskål)	Denticidae	kie (Marshallese)	violent	11
nokogiridai	Gnathodentex aurolineatus Lacépède	"	tunal (Marshallese)	strong	11
aobabudai	Callyodon microrhinos (Bloch)	Callyodontidae	alwor (Marshallese)	slight	12
hanabibera	Cheilinus sp.	Labridae	hirosa (Saipan Japanese) labbo (Marshallese)	slight	12
yashabera	Cheilinus fasciatus (Bloch)	"	jöllöl (Marshallese)	slight	12
kumadoribera	Coris gaimardi (Quoy & Gaimard)	"	lukobinătăt (Marshallese)	strong	13
gichibera	Epibulus insidiator (Pallas)	"	mõ (Marshallese)	mild	14
chagurohata	Cephalopholis argus Schneider	Serranidae	kalemej (Marshallese) kuroganmo (Saipan Japanese, Okinawan)	mild	14
akajin	Plectropomus truncatus Fowler	"	akajin, kurobaniakajin (Saipan Japanese, Okinawan)	mild	15
amadare-dokuhata	Plectropomus oligacanthus Bleeker	"	jule (Marshallese)	violent	16
barahata	Valiola louti (Forskål)	"	kaikbet (Marshallese) akaganmo, akadei (Okinawan, Saipen)	strong	16

madarahata	Serranus fuscoguttatus (Forskål)	"	kuro (Marshallese), kuro (Marshalls Japanese, ishiganmo (Saipan Okinawan)	strong	17
yodarehata	Serranus sp.	"	yudayamībai (Marshallese) saiban (Okinawan)	mild	17
iwahata	Serranus microdon Bleeker	"	illino	said to be strong	17
sazanami-hagi	Ctenochaetus strigosus (Bennett)	Hepatidae	kushiku, kusaku, kuchiku (Saipan Japanese, Okinawan), diebdro (Marshallese)	mild	19
kawari sazanami-hagi	Ctenochaetus sp.	"	teo (Marshallese)	mild	19
montsukihagi	Hepatus olivaceus (Schneider)	"	ael (Marshallese)	poisonous ?	20
katakuro kenran	Hepatus nigrofuscus (Forskål)	"	diebdro (Marshallese)	mild ?	20
raidenhagi	Zebrasoma veliferum (Bloch)	"	laid (Marshallese)	slight	21
akaha mongara	Odonus niger (Rüppel)	Balistidae	bub or bub mej (Marshallese)	strong	22
mongara kawahagi	Balistes conspicillum Bloch & Schneider	"	bub (Marshallese)	said to be poisonous	22
hoshinami-hagi	Aleuteres scriptus Osbeck	Monacanthidae	sensuru (Saipan Japanese, Okinawan)	violent(intes-tines only)	23
kihachijō	Holacanthus diacanthus Günther	Chaetodontidae	jorur (Marshallese)	slight ?	25
koban suzumedai	Abudefduf sexfasciatus (Lacépède)	Pomacentridae	bakej (Marshallese)	slight or none	25

In the reference table and in the following sections the toxicity is classified by degrees of virulence. For example, where one slice (about 200 gr) of flesh is fatal it is called violently toxic. Those resulting in survival with strong impairment of locomotion and inability to stand up are classed as strongly toxic. Where a mild degree of sensory and locomotory impairment results, the toxicity is characterized as mild, and where the species may be eaten with only the possibility of even milder symptoms, it is called slightly toxic. This differs somewhat from the classification used by Fukuda and Matsuo.*

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Section 2 Genus Gymnothorax

Poisonous fishes of the Order Apodes are restricted to the genus Gymnothorax of the family Muraenidae; at least none are at present known in the other families and genera of the Order.

Several species belonging to the genus Gymnothorax are found in Japan. They prefer warm seas, and the Japanese species are found in Central and Southern Japan, being rare and of exceedingly few species in the North. In the South Seas they are abundant, with a large number of species. They are especially plentiful in coral reef areas where they lie in the reef during the day and come out to feed at night. Although they do not, of their own accord, attack aggressively during the day, if in diving one puts a hand or foot directly in front of their hiding places, they will bite. Because of the severity of their bite most members of this genus are regarded as venomous fish, but no poison glands have been found near their teeth and consequently they should be considered simply as biting fish. Their teeth are sharp and are hinged at the roots so that although they can lie flat within the mouth, they cannot be bent forward at more than a right angle to their base. For this reason they are well-designed for directing food into the mouth. A finger or other member taken into the eel's mouth cannot be drawn out, and if it is withdrawn forcibly, it is mangled and sliced. Teeth of this type are called hinged teeth and are a taxonomic character of the genus.

Those found in Japan and called utsubo, nada, namada, gidako, and so forth are mostly the utsubo, scientific name Gymnothorax kidako Temminck and Schlegel (Fig. 7). There are several other species. The flesh of the utsubo is despised in some localities, but in others it is prized and is eaten as a staple article of diet without there having yet been a case of poisoning reported.

In the South Sea islands, particularly in the Marshalls, the species of this genus are numerous, and they are classified by the natives under two different names, dreb (also written leb or deb) and maj. The former designates the comparatively dark-colored species, the latter is applied to the lighter ones. According to the natives, the dreb is poisonous, but the maj is edible and is in fact used for food. At Saipan, also, the ones

*Tokushi Fukuda: Prevention and cure of tetraodont poisoning, in Supplementary Medical Lectures (Hoshū Igaku Kōza), p. 3. Kanahara Shōten pub.

which are called jaunagi [snake eel] and feared as poisonous fish are only the dark-colored species. There are several species of dark ones and several species of light ones, and it is thought that there must be some variation in toxicity as between species. The author tested three species of dreb, and although the three species called maj and eaten by the natives were not tested, they are cited as nonpoisonous for purposes of comparison. As can be seen from the plate, those which are called maj and which are supposed to be white vary in degree of whiteness and are variously spotted so that there is no way of telling clearly which are to [Page 20] be considered maj. The designation varies with different natives and from island to island and is nothing but a vague generalization based on outward appearance. It would be dangerous to use it to determine the edibility of a species. The same can be said of those called dreb. From its general appearance the utsubo, which is eaten in Japan, would have to be counted among the dreb.

1. Dokuutsubo (Plate 1, Fig. 1)

Scientific name - Gymnothorax flavimarginatus Ruppell
Local name - dreb (Marshallese), jaunagi (Japanese residents)
Distribution - East Africa, Indian Ocean, South Seas, Philippines, Hawaii.
Morphological characteristics - Snout thick and short, head likewise. Black spots in imbricated pattern on body, especially white-edged black spots around gill opening. Single row of teeth in upper jaw. Head length goes 8 or 9 times in body length, 3.5 in trunk.

This is the most common eel of the coral reefs and can easily be caught on set lines or by angling from the shore.

The flesh was fed to cats and mice with the following results. [Tables 1, 2, 3]

[Page 21]
The mice, in proportion to their weight, ate approximately ten times as much as the cats, but showed only sensory impairment with no deaths. Thirty grams of cooked or raw flesh given to the cats produced violent poisoning (Table 1). Table 3 shows a comparatively low degree of toxicity. From the appearance of the poisoned animals it is thought that a lethal quantity is probably much less than the quantity consumed.

As an example of poisoning in humans, we heard of a case in which about 200 grams of the flesh of an eel of this species, taken by angling from shore, was roasted and eaten by three persons, two of whom died that night.

This species is one of the most violently poisonous fishes. The toxic element appears to resist heat, and roasting or steaming does not reduce its toxicity. Its effectiveness was not changed by heating at 100° for 10 minutes.
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2. Shiromon dokuutsubo (Plate 1, Fig. 2)

Scientific name - Gymnothorax meleagris Shaw
Local name - dreb (Marshallese), jaunagi or hanabiutsubo (Japanese)
Distribution - East Africa, Indian Ocean, South Seas, Philippines, Hawaii.
Morphological characteristics - two rows of teeth in upper jaw, gape large, from snout to corner of mouth is somewhat more than 1/3 of head length. Head is long, going 1.7 to 2.9 times in trunk length. Coloration varies; the plate represents one type, but in some the white markings are further reduced to fine dots. In others the area of the white markings is increased and the dark brown ground color is decreased until it is hard to say whether it is a reticulated pattern of dark brown on a white ground or an imbricated pattern of white markings. Although there are scientists who treat these forms as different species, it is thought that they are all variations or varieties. In all of those which were tested the white spots were distinct, as shown in the figure, and for this reason it was unfortunately impossible to gain any knowledge of the toxicity of the other varieties, however, from what the natives say, it is presumed that their toxicity is probably the same. Fewer of this species were taken than of the preceding. [Table 4]

The above results show that of two animals eating the raw flesh, one which had taken 0.8 grams died. One which ate 0.8 [sic] grams of liver had diarrhea, its coat was ruffled, and it appeared weakened but it recovered the following day.

The natives say that this species is not as virulent as the preceding, but that there have been deaths caused by it. This species is also considered violently toxic.

3. Namiutsubo (Plate 1, Fig. 3)

Scientific name - Gymnothorax undulatus (Lacépède)
Local name - dreb (Marshallese), jaunagi (Japanese)
Distribution - Indian Ocean, E. Indies, South Seas, Philippines, Hawaii.
Morphological characteristics - one row of teeth in upper jaw. Head length goes $6\frac{1}{2}$ to 8 times in body length, 6.2 to 7.2 in trunk. Length from snout to corner of mouth goes 2 to $2\frac{1}{2}$ times in head length. Markings extraordinarily variable: Those with a dark ground color, as shown in the plate, are most common, but there are those in which a white ground color merely forms a reticulated pattern and others which, like the variety isingteenus (Fig. 4) described in the next section, have dark markings on a white background. It is difficult to distinguish the varieties other than by their coloration.

This species is also widely distributed and is one of the eels commonly seen in the South Seas. [Table 5]

Toxicity. The tabulated results of the animal experiments show that one mouse which consumed 1 gram of cooked flesh showed some ill effects. Another which ate 0.6 gram of flesh , salted and dried in the sun (not completely dried, should be called half-dried) also suffered some ill effects. Since sensory reactions were not tested on any of these eight

specimens, no conclusion can be reached on this point.

All natives who were asked about this species said that it was poisonous.

This species is probably somewhat less poisonous than the preceding ones.
[Page 24]

4. Amadareutsubo (Plate 2, Fig. 4)

Scientific name - Gymnothorax favagineus var. isingteenus (Richardson)
Local name - maj (Marshallese)
Distribution - Indian Ocean, East Indies, Marshalls.
Morphological characteristics - Generally identical with the species described above, but the coloration is entirely different. Various scientists have recognized it as a variety of the preceding species, and since large specimens are never seen, ones measuring from 40 to 50 cm being abundant in the coral reefs, it is possibly an immature form.

Toxicity. Although this is merely a color variation of the preceding species, the natives say that it is not poisonous. Since the results of our experiments have shown that the preceding species is pretty clearly poisonous, it is very interesting that such similar varieties can differ completely in toxicity.

5. Aseutsubo (Plate 2, Fig. 5)

Scientific name - Gymnothorax pictus AhI
Local name - maj (Marshallese)
Distribution - Indian Ocean, E. Indies, South Seas, Philippines, Hawaii.
Morphological characteristics - The canine teeth in the snout in this species are not slanting fang-shaped hinged teeth, but are coniform. They are not especially large and do not differ in any way from the other teeth. The markings change markedly with age. Figure 5 represents an old specimen. In young ones the dark spots are larger and fewer. In a young specimen about 10 cm long the white ground color was divided into about three rows and in each row there were only about 50 dark brown spots. This species attains a length of 70 cm, but those commonly taken run about 50 cm. Abundant in coral reefs.
[Page 25]

Toxicity. This species was taken just before our departure so we could not test it.

According to the natives this species, like the preceding one, is edible and well-flavored. They do not distinguish it from the preceding species, give it no special name, and accordingly have the same notion as to its edibility.

6. Shiroutsubo (Plate 2, Fig. 6)

Scientific name - Gymnothorax thyrsoideus (Richardson)
Local name - maj (Marshallese)
Distribution - Burma, E. Indies, South Seas, W. Australia, Hawaii.
Morphological characteristics - Coniform teeth like the preceding species but differs in having a double rather than a single row of teeth in the upper jaw. Ground color brownish with minute spots scattered over the whole body. Body length reaches 70 cm, a small size for a moray.

Toxicity. Not tested. Jaluit natives do not distinguish it from the two foregoing species and say that it is just as nonpoisonous as they are.

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Section 3 Genus Sphyraena

The genus Sphyraena of the family Sphyraenidae, Order Acanthopterygi, includes many useful edible fishes.

The sphyraenids of Japan such as the akakamasu (Sphyraena pinguis), the aokamasu (S. nigripinnis) and others are generally prized as delicious edible fish, and we have heard of no case of poisoning attributed to them.

In the tropical and subtropical areas of America the sphyraenids are called barracuda, and since they attain a large size, they are well known as food and game fish. The species are Sphyraena picuda, S. becuna, S. barracuda, as well as others, and it has long been known that in America they sometimes cause poisoning. There are various theories about this, one being that they are only poisonous during the annual spawning season. At the island of St. Domingo, they are supposed to be poisonous from May to October. Poey* has stated that in Cuba only old fish of 3 pounds weight and over are poisonous. Günther** has stated that the barracuda is poisonous only when it is feeding on poisonous sardines.

Of the two species of poisonous sphyraenids of the South Seas known to the author, one is also found in American waters. This is S. picuda, which has previously been known to be poisonous, and it is worthy of note as an evidence of the fact that among the poisonous fishes are to be found some widely distributed species.

1. Dokukamasu (Plate 3 Figure 8)

Scientific name - Sphyraena picuda Bloch & Schneider
Local names - kamasu, kamasa, shikirukamasa (Japanese), jujukob (Marshallese)
Distribution - Indian Ocean, tropical Pacific, America, tropical and subtropical Atlantic coast.
Morphological characteristics - Dorsal V, 9; and II, 7. Scales in lateral line 80. Mouth extends to a point vertically below anterior edge of the

*Poey: Ciguatera, Memoria sobre la enfermedad. Report fisico-nat. de la Isla de Cuba. II p. 1-24. 1867 (from Pawlowsky)

**Günther:- Handbuch der Ichthyologie. Wien, 1886.

pupil. Attains a length of more than one meter. Occurs in surface waters all over the South Seas. Easily caught on trolling gear and long lines. [Tables 6, 7, 8]
[Page 28]

Toxicity. As shown in the table, of two cats tested, the one which took 7.2 grams of cooked flesh died after 20 hours. Of 4 mice which ate the liver, one which took 1 gram showed some ill effects, and of 10 which ate muscle tissue, 2 which ate cooked tissue were affected.

A case was described at Jaluit in which a ship's crew of more than ten men were all poisoned to such an extent that the functioning of the limbs and of the mouth was impaired in some of them, while others were unable to stand up. The fish was said to have been over one meter in length.

In another case at Saipan sixteen fishermen ate the fish and only one of them was poisoned. According to this man's story, a short time after eating (about 5 minutes) he vomited. After that he began to feel a numbness spreading from around his mouth. He felt as if his body were floating in space, his feet would not hold the ground, and he became as if drunk on sake. After staying in bed for 2 or 3 days he recovered.

The Jaluit natives say that the larger fish are violently poisonous. They also say that they do not know of any particular season for eating this fish.

The specimens caught by the author were all of about 90 cm, and it was unfortunately not possible to test small fish, however, the large ones were, as shown above, very clearly poisonous. It is interesting that the natives' statement that only the large fish are poisonous is in agreement with Poey's observations in Cuba.

Although it is certain that the larger barracuda of which the natives speak belong to this species, it may be that the small ones are not the young of this species but rather that they belong to the species described in the next section. There is room for further study on this point. These two species of barracuda are not differentiated by the Japanese except as to size; they only know that some of the Marshallese consider them separate species. There is doubt on this point, but the dokuhiraaji described later in this report presents the same phenomenon, that is to say, only the large ones are poisonous. The settlement of the question of whether Poey was right about this species or whether it is a matter of confusion with a different species must be left to a later time. Also, in regard to the problem of whether these fish are especially poisonous during an annual spawning season, we have not made a year-round investigation and consequently have no data, even the spawning season being unknown.

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9. Omekamasu (Plate 3 Figure 9)

Scientific name - Sphyraena forsteri Cuvier & Valenciennes
Local name - jure (Marshallese)
Distribution - Indian Ocean, South Seas, Fiji
Morphology - Very similar to the above species, differing principally in that the mouth is smaller with the corner of the mouth not reaching as far as the anterior rim of the eye. Scales small, 123 on the lateral line. Eye large, going about 6 times in the head length (in the preceding species it goes about 9.3 times). Does not become as large as the

preceding species, those commonly taken being about 40 to 60 cm in length with none reaching 1 meter.

Plentiful outside the encircling reefs and fringing reefs, they are easily taken on angling and trolling lines. [Tables 9, 10]
[Page 30]

<u>Toxicity</u>. Of the 4 cats used in the experiment, 2 which ate cooked flesh and one which ate raw flesh showed extremely slight sensory and locomotory impairment. Of 9 mice only one showed functional impairment of the hind legs.

Judging by these results this species may be said to be slightly poisonous. Matsuo's paper is the only known example in the literature which cites this species as being as poisonous as the preceding species.

According to some Marshallese, only the fish taken at Jabor island in the Jaluit atoll are slightly poisonous while those taken at the other islands are nonpoisonous. The toxicity of specimens from Jabor was of the degree described above. The natives appeared to have no qualms about eating this fish, and, while informing the author that it was poisonous, went right on eating it. The Marshallese distinguish this species by a separate name from the preceding species, which they do not eat. Most of Japanese apparently make no distinction between these two species of barracuda.

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Section 4 Genus <u>Caranx</u>

Most of the many species of the genus <u>Caranx</u>, family Carangidae, are useful foodfish and are handled as a high-grade article in fish markets in Japan and all over the world.

A very few of these species have been considered poisonous for many years. According to Pellegrin*, Caranx fallax is poisonous at Havana. He also records <u>C. plumeri</u> as poisonous, specimens containing poison being said to have red bones. Poey (op. cit. p. 25) also records <u>Seriola gigas</u> and <u>Seriola lalandi</u> of the closely related <u>Seriolidae</u> as being poisonous in Cuban waters.

Although these species are very similar to the seriolids and carangids of Japan, we have heard of no cases of poisoning caused by these fish in this country.

The species of carangids inhabiting the South Seas area are very numerous, probably over 100, and it was impossible to collect and test them all in the short time at our disposal so we omitted those species which are commonly used for food and investigated only the following two species, which have frequently caused cases of poisoning.

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*Pellegrin:- <u>Les poissons vénéneux.</u> Thèse de Paris. 1889 (from Pawlowsky)

1. Dokuhiraaji (Plate 4 Figure 10)

Scientific name - Caranx melampygus Cuvier & Valenciennes
Local name - lañe (Marshallese), gāra (Okinawan fishermen), generally called hiraaji by Japanese
Distribution - Red Sea, Indian Ocean, tropical Pacific, taken rarely in Ryūkyūs.
Morphology - First dorsal VIII, second dorsal I, 24. Anal II / I, 19 - 20. Scutes on straight portion of lateral line 36 - 38. Eye very small, posterior end of maxillary extends to a point directly beneath the anterior edge of the pupil. Attains large size; specimens over one meter in length are not unusual. [Page 32] [Tables 11, 12, 13]

[Page 33] [Tables 14, 15]

[Page 34]

Toxicity. Results of experiments with animals were as shown in tables 11 - 19.

The two cats eating raw flesh, two eating cooked flesh, and one eating liver showed marked symptoms of poisoning (except for one which ate raw flesh without ill effects), and one which ate 10 gr of liver died. In the 62 experiments with mice the technique for detecting symptoms was unsatisfactory in most cases, and only the 13 animals recorded in tables 18 and 19 showed any reaction. In these cases those which ate cooked flesh, raw flesh, blood, or liver all exhibited fairly clear signs of poisoning. [Tables 16, 17]

[Page 35]

The two fish tested were 90 and 71 centimeters long. Comparing the two, the 90 cm one produced a clearer reaction in both the cats and the mice. Considering the various organs, it appears that the blood and the liver are of marked toxicity.

The popular opinion (especially at Saipan) is that this species is one of those most frequently responsible for cases of poisoning. Judging from the results of inquiries among fishermen, doctors, and natives, poison in this species is limited to the large individuals and most cases seem to have resulted from eating cooked flesh from the head.

[Page 36]

In the four animal experiments in which we especially tried to use flesh from the head region, it was difficult to detect any more marked toxicity than in the other cases, although cases of poisoning in human beings show that tendency. Of the two fish tested, the toxicity of the 71 cm specimen was inferior to that of the 90 cm one, which agrees with the tendency reported in cases involving human beings.

Small fish (around 30-40 cm) are widely sold for food, but those of one meter or more in length appear not to be eaten. Most cases of poisoning seem to occur when, occasionally, one of a medium size is eaten. We ourselves were served this fish prepared as sliced raw fish, the length of the fish being unknown to us, and no poisoning resulted.

According to fishermen, persons who fear poisoning if large specimens are eaten in an unprepared condition, soak the fish overnight in ice water and the next day prepare fishcake from it for sale; no cases of poisoning as a result of this procedure have been reported. It is wondered whether this is because the toxic element can be washed out in water. (See Section 5 of Chapter IV on eliminating the poison).

Cases of poisoning reported for this species are all light, involving slight impairment of the sensory or locomotory functions even where rather large quantities have been consumed. The seve est cases recover in three or four days and no deaths were reported.

The following conclusions are drawn from the above information:

Fish under 40 cm in length are nonpoisonous. Fish over 70 cm long are mildly poisonous. Those in between are slightly poisonous, however, it is thought that there must be considerable variation depending on the individual fish and on the individual eating the fish so, except for those which are only slightly poisonous (those which may be eaten without serious trouble), it would be safest to eat only fish under 40 cm long.

2. Niramihiraaji (Plate 4 Figure 11)

Scientific name - Caranx lessonii Cuvier & Valenciennes
Local name - mindanagāra (Okinawan), ikubuj (old fish, Marshallese), kubkub (immature fish, Marshallese)
Distribution - Indian Ocean, tropical Pacific, Formosa
Morphology - Eye much larger than preceding species, easily distinguishable. Mouth also large, posterior end of maxillary extending as far as posterior edge of eye. First dorsal VIII; second dorsal II, 20-21; anal II + I, 16-17.
[Page 37] [Tables 20, 21, 22]
Scutes on straight portion of lateral line, 30. Does not reach a large size, the largest seen by the author being about 20 cm [sic] . Can be readily distinguished from the preceding species by the characteristics listed above.

Toxicity. Three specimens (51 cm, 49 cm, and 23 cm in length) were tested. Toxicity was marked in all but the 23 cm one, 17.5 gr of flesh producing conspicuous symptoms of poisoning in a cat weighing 0.8 kg. With the specimen 23 cm long, 37 gr of flesh caused no ill effects in a cat weighing 0.3 kg, and although only one test was made with this specimen, it appears that in this species, as in the preceding one, only large fish are poisonous.

The Marshallese draw a strict distinction between large and small fish of this species, believing them to be different species. They call large ones ikubuj and small ones kubkub. Ikubuj are considered poisonous, while kubkub are a staple food fish. As the plate shows, the coloration of the [Page 38] ikubuj is darker than that of the kubkub and it looks like an altogether different species. Nevertheless, not only can no important morphological difference be detected (slight differences in body depth and eye diameter are probably due to age differences), but specimens of an intermediate size show an intermediate coloration, and so they are considered to be the same species.

Natives, when shown fish of various sizes, identified as kubkub those below 30 cm in length.

According to the results of experiments with animals, specimens less than 30 cm in length may be eaten, but those of around 50 cm must be considered strongly toxic.

Besides the kubkub the natives say that two other species of carangids, the rewa and the aron, are eaten, but we were unable to collect them. It

appears that there are no poisonous carangids besides these two species in the Marianas, Marshalls, and Carolines.
[Page 39]

Section 5 Genera Lutjanus and Aprion

The genera Lutjanus and Aprion belong to the family Lutjanidae. These fish are abundant throughout the tropical Pacific, and the number of species is large. Some are also found in Japanese waters, but in comparison with the South Seas they are very few.

The genus Lutjanus includes many useful food-fish, and also numerous kinds of poisonous fish. Very few of them have been previously reported as poisonous.

These fishes are caught with driving-in nets and by angling, and, because poisonous species are taken mixed in with edible species, caution is necessary.

1. Akadokutarumi (Plate 5 Figure 13-1)

Scientific name - Lutjanus vaigiensis (Quoy & Gaimard)
Local name - akamasu, akana, akadai (Saipan Japanese)
Distribution - Indian Ocean, Malaya, South Seas, N. Australia
Morphology and taxonomic information - This species very closely resembles in form and coloration the okifuedai (Plate 5 Figure 13-2) (called dokugyo or dokutarumi) of Japan, however, there is a definite difference between the two. In the okifuedai the rows of scales above the lateral line on the caudal peduncle are horizontal and run parallel to the lateral line, while in this species these rows slant upward caudad and cross the lateral line at an angle instead of running parallel to it. The pored scales of the lateral line in this species are 56-57, while in the okifuedai they are not more than 48-50. Generally in this species the scales are smaller with 18 scales in a diagonal row counting from the origin of the anal fin, whereas a similar count on the okifuedai gives 14 (10 in Jordan's figure). Although it is a character which may vary with age and so be unsuitable for comparison, in specimens of approximately the same length the pectoral fins of this species were longer. On a specimen of about 50 cm the tip of the fin extended to a point vertically under the last spine of the dorsal. In the okifuedai it extends only as far as the eighth spine. In this species the caudal fin is deeply notched in the middle forming a forked outline while in the okifuedai the posterior edge is either nearly straight
[Page 40, Tables 23, 24, 25]
[Page 41, Tables 26, 27]
[Page 42, Tables 28, 29, 30]
[Page 43, Tables 31, 32]
[Page 43] and truncate or is only slightly indented. These differences cannot be considered local variations, and they are therefore judged to be separate species. Fowler (1931) considered the direction of the rows of scales above the lateral line important and set up several subgenera of Lutjanus based on this difference.*

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*Fowler 1931. U. S. Nat. Hist. Mus. Bull. 100, Vol. 11. p. 190

According to his classification, the okifuedai belongs to the subgenus Raizaro Jordan & Fesler, and this species belongs to the subgenus Neomaensis Girard. The scientific name Lutjanus vaigiensis (Quoy & Gaimard) has in the past been applied to the okifuedai, however, although we have not been able to see the original citation and cannot tell which species is meant in other older citations, it seems proper to give the name Lutjanus vaigiensis to this species, since it agrees with Fowler's description, and to consider the okifuedai a different species. Furthermore, this species is, as shown [Page 44] below, poisonous while the okifuedai, although called dokugyo [poisonous fish], is said to be nonpoisonous by the people of Jōnoike [浄之池] in Izu and is eaten by them. It is an interesting question how the fish got the name dokugyo.

Toxicity. Cats which ate 47.1 gr of raw flesh, 40.7 gr of cooked flesh, and 15.2 gr of liver all showed marked reactions and died. One which ate 34.7 gr of cooked flesh showed no ill effects. In the experiments with mice there was very little reaction noted.

Not a few cases of poisoning in human beings have been caused by this species. It is one of the most common lutjanids and large numbers are caught.

The following account was given by fishermen at Saipan who had experienced poisoning from this fish.

"They went fishing at Laulau Bay and could catch nothing but akamasu. An old man warned them, but they cooked the fish and ate it. All fourteen of them were stricken, some of them having eaten hamasoki (an antitoxic plant described in a later chapter) along with the fish. Two hours, or four to five hours at the latest, after eating, their tongues, lips, fingers, and toes hurt. They had cramps. Their fingers became clenched to the palms of their hands and could not be opened. They could not stand up and had to lie there for two nights. Their nerves throbbed with pain, and they had bloody diarrhea. At that time they felt as if their bellies were on fire. Seven of them were cured of roundworms as a result, and later felt fine."

It is thought that the toxicity of this species should be classed as mild or strong.

2. Futatsuboshidokugyo (Plate 5 Figure 14)

Scientific name - Lutjanus bohar (Forskål)
Local name - baan or pan (Marshallese), akamasu (Japanese)
Distribution - Red Sea, Indian Ocean, Philippines, South Seas, Hawaii
Morphology - At first glance this species is very similar to the preceding, but it can be distinguished by its flatter and deeper body. Examining more detailed characters, the alignment of the scales on the caudal peduncle is horizontal in this species, there are about 60 scales on the lateral line, the diameter of the eye is greater, and the notching of the preoperculum is slighter. The coloration of this species is quite similar to that of [Page 45] the preceding species and it is difficult to distinguish between them on that point alone. Past citations have described two white spots on the back as a characteristic of this species, and Bleeker* in his

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*Bleeker, P.: - Atlas ichthyologique des Indes Orientales.

figure showed well-defined white spots, however, the author's experience has been that these small white spots can hardly be observed in freshly-caught specimens. Neither the author nor the artist noticed them in the field. It was only when the specimens were re-examined after having been preserved in formalin for about two months that these spots could be clearly seen, and we could resolve our doubts as to the identity of the species. In the figure the two spots have been somewhat exaggerated in order to show their location.

This species has long been known to be poisonous. Jordan and Seale (1906)** reported it from Samoa with the local name of mumea as the only fish other than monacanthids and tetraodonts which is always poisonous there. Mr. Shigeho Tanaka*** has also described the species.
[Table 33]

Toxicity. Tests with this species were unsatisfactory because the amount of material available was too small. Cats consumed 17 gr. without any ill effect, and mice showed no reaction.

According to the Marshallese, this species is poisonous at Jaluit but is eaten at Ebon Island. Local residents also say that if kept in tide pools, these fish lose their toxicity. Be that as it may, in fish which show such variations in toxicity, the variation as between individual specimens is often very great. The experiments with animals described above were made with only one specimen and consequently were inconclusive.

The toxicity of this species is considered to be mild or slight.

[Page 46]

3. Fuedokutarumi (Plate 6 Figure 15)

Scientific name - Lutjanus (Loxolutjanus) sp.
Local name - jab (Marshallese), fuena, mimija (Okinawan)
Distribution - Saipan, Marshalls
Morphology - This species closely resembles Lutjanus gibbus, there being almost no difference on morphologically important points. Only the coloration gives an impression of marked difference at first glance. In L. gibbus it is a vivid red while in this species it looks just as if it had faded out to a light pink. The coloring of the figure does not convey this impression satisfactorily, but it is a coloration which is difficult to show in a drawing. It resembles the color of freshly-polished copper but is lighter. This is the coloration even when the fish is first taken from the water. Since it would be out of place to take up detailed morphological differences here, they will be left for another time. The author has seen L. gibbus taken in large numbers and used for food at Palao.

Toxicity. In experiments with cats one animal exhibited a strong degree of impairment of sensory and locomotory functions. Of 14 mice tested, 5 showed some effects. [Table 34]
[Page 47] [Tables 35, 36]

Natives both at Saipan and in the Marshalls consider this fish strongly toxic

**Jordan and Seale:- (1906) Fishes of Samoa.
***Tanaka, Shigeho:- (1914) Zoological Magazine, Vol. 26, No. 319, p. 412.

4. Misekurohoshitarumi (Plate 6 Figure 16)

Scientific name - Lutjanus fulviflamma (Forskål)
Local name - jeblo (Marshallese), fish with black spot on only one side are said to be called bõtowetak.
Distribution - Red Sea, Indian Ocean, South Seas, NW. Australia
Morphology - Body shallow with a black spot above the lateral line below the soft part of the dorsal fin.

Toxicity. In experiments with mice at Saipan, no ill effects were noted. No results were obtained from the experiment in the Marshalls. According to the residents of the Marshalls, this species has caused cases of poisoning through be-
[Page 48] Tables 37, 38
ing mistaken for the jab. Some persons said that this fish is poisonous at certain islands or at certain times, while others stated that fish with black spots may be eaten and fish without black spots (probably jab) may not. Those which have only one spot either on the left or right side (not seen by the author) are called bõtowetak and are said to cause poisoning sometimes. This information all came from old men.

From the foregoing this species is judged to be nonpoisonous or slightly poisonous.

4. Yoitarumi (Plate 6 Figure 17)

Scientific name - Lutjanus flavipes (Valenciennes)
Local name - jaj (Marshallese)
[Page 49]
Distribution - Indian Ocean, South Seas
Morphology - Body deep, alignment of scales same as in preceding species, horizontal below lateral line, slanting upward posteriorly above lateral line. A coloration characteristic is the white coloring of the posterior edges of the dorsal and caudal fins.

Toxicity. Only one test was made, a cat being used. No ill effects were noted, perhaps because the amount eaten was too small. The natives say that cases of poisoning caused by this species are light and extremely rare.

This species is thought to be probably nonpoisonous or very slightly poisonous.
[Table 39]

5. Yūdachitarumi (Plate 7 Figure 18)

Scientific name - Lutjanus semicinctus (Quoy & Gaimard)
Local name - elikimi (Marshallese)
Distribution - Indian Ocean, South Seas
Morphology - Readily distinguished from other species by its characteristic coloration. Although there are no other species in this family with similar coloring, there may be a possibility of confusing it with similarly colored species of other families.

This species is rarely taken.

Toxicity. No effect was noted in animal experiments. The Marshallese give

conflicting testimony as to its toxicity. Some say it is poisonous, others that it can be eaten. It is said to be eaten at Ebon. Since it is taken comparatively rarely and may be confused with fishes of other families which closely resemble it in general appearance, it is impossible to give a definite opinion.
[Table 40] [Page 50]

In any case, it is judged to be either nonpoisonous or very slightly poisonous

6. Sujitarumi (Plate 7 Figure 19)

Scientific name - Lutjanus kasmira (Forskål)
Local name - jetar (Marshallese)
Distribution - Red Sea, Indian Ocean, S. China, Philippines. Formosa. S. Honshū
Morphology - Readily identified by its characteristic coloration.

Toxicity. Completely nonpoisonous. Large quantities are caught and sold as food fish. We ourselves ate this species with no ill effects. No experiments were performed, but since the species also occurs in Japan it is cited here for the information of those who may suspect it of being poisonous. The flavor is delicious, resembling that of the isaki [Parapristipoma trilineatum (Thunberg)] of Japan.

7. Aona (Plate 7 Figure 20)

Scientific name - Aprion virescens Valenciennes
Local name - aona, aomachi, aomasu, ōmachi (Saipan Japanese), suzuki (Marshalls Japanese)
Distribution - N. Australia (Queensland), Inner South Seas, Hawaii area
Morphology - Dorsal XI, 9, anal III, 8. Body shallow and thick, nearly fusiform. Scales of lateral line 48. Color silver, bluish dorsally, belly silvery white. (The figure is too blue all over the body.) The species attains lengths of nearly one meter.

Toxicity. Of two cats experimented with, the one which ate the cooked flesh vomited and apparently did not assimilate the poison, for no other ill effects were noted. The one which ate raw flesh showed no reaction. Of 12 mice, three which ate cooked flesh and two which ate raw flesh showed some reaction.
[Page 51]
At Saipan the natives said that fish of this species taken at a point four miles west of Charanka invariably cause poisoning. Like the dokuhiraaji [Caranx melampygus], this fish can be soaked overnight in icewater and made into fishcake the following day without causing poisoning.

In the Marshalls this species is said to cause slight poisoning, that is, the victim does not die but only feels intoxicated (jirik kalek in the native language)

This species is easily taken. The author was aboard a vessel from which, during freight - carrying operations, a specimen nearly one meter long was caught from the deck. The crew were about to eat it, but when they asked the natives whether it was all right, they were told that it was kalek.
[Tables 41, 42] [Page 52]

However, when the crew went to throw it away, the natives asked for it and took it away with them, probably for their own consumption.

The toxicity of this species is considered to be of a mild or slight degree.

Section 6 Genus Lethrinus

The genus Lethrinus is composed of fishes belonging to the family Lethrinidae (formerly included in the family Sparidae). The most common species in Japan is L. haematochir, which occurs in southern Japan, and which, because the inside of its mouth is flame-colored, is called kuchibitai, kuchimi, kuchibi, fuefukitai, etc. [These names mean "fire-mouth" and "flute-blower".] The genus includes many other edible fishes. They have in the past been taken in large quantities by trawlers in the China Sea and South China Sea areas.

Fishes of this genus have for many years been recorded in the literature as being poisonous. Vaillant (1887)* described L. rostratus from the Pomotous [sic] as poisonous, and Pellegrin (1889)** reported that at New Caledonia large specimens of L. mambo 80 cm long were poisonous while small ones of 13-14 cm were nonpoisonous

Poisonous fishes of this genus in the South Seas area are the four species described below, but the genus also includes many edible fishes and large numbers of them are marketed.

The author asked one Japanese in the area studied for his opinion on the poisonous fish situation and was told that fishes with pointed mouths are poisonous. As is apparent from this report, this rule cannot be universally applied to fish as a whole, but it can be said to be true of the members of this genus which occur in the South Seas.

1. Kitsunekuchibi and Usugumokuchibi
(Plate 8 Figures 21, 22, 23)

Scientific name - Lethrinus miniatus (Schneider)
Local name - Variety shown in Fig. 21 is called jalia (Marshallese); Japanese call it omonaga (long-face). Variety shown in Fig. 22 is called roñet (Marshallese) and that in Fig. 23 mameni (Marshallese).
Distribution - Red Sea, Indian Ocean, South Seas.
Morphology - This species abounds in varieties of coloration. There are three types which are thought to belong to this species or to be closely related, and the natives distinguish them by different names. When shown our three drawings they [Page 54] definitely identified the roñet and mameni, but in the case of the jalia they indicated not only figure 21 but also applied the name to figures 22 and 23. It is thought that of these three types, two should be considered varieties of a single species. It is difficult to detect any particular differences on important points of morphology. (There is some difference in body depth). There are some differences in the coloration and the natives probably make their distinction on this basis. The roñet is darker than the jalia and the cloud-like pattern on its

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*Vaillant (1887); Bull. Soc. Philom. p. 49 (from Pawlowsky)
**Pellegrin (1889, Les poissons vénéneux. Thèse de Paris 1889 (Pawlowsky)

sides tends to form spots. The wavy blue lines on the cheeks are more difficult to detect. The body of the jalia is lighter colored and the cloud-like pattern is plain, resembling clouds trailing horizontally. Several wavy blue lines can be clearly seen on the cheeks. These two varieties can hardly be considered local variations. (Both occur in the Marshalls, but the ronet variety was not collected at Saipan.) Neither can they be definitely said to be variations due to sex or age, however, in general it appears that the jalia variety predominates among small fish while the ronet type appears more frequently among larger ones.

The usugumokuchibi shown in figure 23 is called mameni and is pretty clearly distinguished in the Marshalls. It very closely resembles the two varieties described above, the main points of difference being that the cloud pattern on the sides is very faint and obscure, and the blue lines on the cheeks are not clear. It also has a longer snout and a longer caudal peduncle than the foregoing

[Table 43]

[Page 55] [Tables 44, 45, 46]

two varieties. It is thought that the mameni should be recognized as a distinct species, but only the major points of difference have been recorded here, leaving the details for another time.

Toxicity. As shown in the tables, of the two varieties of kitsunekuchibi the jalia had no effect on two cats, and only the two mice which ate cooked flesh showed any ill effects. The fish tested was 42 cm long.

The natives say that large fish of this species are strongly toxic. The author recalls seeing specimens over 60 cm in length.

In tests with the ronet variety of kitsunekuchibi using a specimen of approximately the same length, two cats showed definite symptoms of poisoning. According to residents of the Marshalls, this variety is the most poisonous and often causes death when eaten. This species should be considered violently or strongly toxic.

[Page 56]

No effect was perceived on the cat which ate 20 gr of usugumokuchibi (mameni). It appears to be less poisonous than the ronet variety of kitsunekuchibi. The natives, however, say that this species is poisonous. Perhaps it should be considered mildly toxic.

2. Muneakakuchibi (Plate 9 Figure 24)

Scientific name - Lethrinus variegatus Valenciennes
Local name - net (Marshallese)
Distribution - Red Sea, Indian Ocean, South Seas, Philippines
Morphology - The vermilion spot at the base of the pectoral is characteristic. There is a faint cloud pattern on the body. Blackish spots and lines on the cheeks. Similar black spots are scattered along the sides. Resembles in general appearance the hōakakuchibi described in the next section, but if attention is paid to the points detailed above they can easily be distinguished.

Toxicity. As shown in the table, two cats and two mice showed marked symptoms of poisoning. This species is judged to be strongly toxic.

[Table 47]
[Page 57]

3. Hōakakuchibi (Plate 9 Figure 25)

Scientific name - Lethrinus sp.
Local name - woeo (Marshallese)
Distribution - Marshalls
Morphology - Easily mistaken for the preceding species, even the natives sometimes confusing the two species. Nevertheless, if examined carefully they can easily be told apart. In this species the vermilion spot is on the oper ole, and there are no dark spots on the head and sides as in the species described above.

Toxicity. The resutls of the experiment recorded in the table indicate that this species is nonpoisonous. The natives eat it. We were careful to cite it here for purposes of comparison because it is occasionally confused with the preceding species and considered poisonous.

[Table 48]

4. Amakuchibi (Plate 9 Figure 26)

Scientific name - Lethrinus kallopterus Bleeker
Local name - pelak (Marshallese)
Distribution - Indian Ocean, South Seas, Philippines
Morphology - This species is deep-bodied, the snout is short, the fins are red (although this is overemphasized in the drawing), and it is easily identifiable. Large quantities are caught for food.
[Page 58]
[Table 49]

5. Matokuchibi (Plate 10 Figure 27)

Scientific name - Lethrinus harak (Forskål)
Local name - No special name. A kind of omonaga (Saipan Japanese)
Distribution - Red Sea, Indian Ocean, South Seas, Philippines
Morphology - Body deep, snout short, large black spot with indistinct outline on the sides. This species is in general use as a food fish.

[Page 59]

Section 7 Family Sparidae

Fishes of this family are generally edible, but the two species cited here are poisonous. There have been few references to these fish in the literature. (The kie lo lan of Mr. Matsuo is probably a dokudai.)

1. Dokudai (Plate 11 Figure 31)

Scientific name - Monotaxis grandoculis (Forskål)
Local name - kie (Marshallese)
Distribution - Red Sea, Indian Ocean, South Seas, N. Australia, Philippines, Hawaii area
Morphology - Eye large, body deep, color blackish, fins red. The body is silver with the head and back blackish. (The figure is not an accurate representation).

Toxicity. The results of the animal experiments shown in the table indicate

that its poison is one of the most virulent. In the cat which ate 14 gr, it produced violent symptons ending in death. Small fish of this species (about
Table 50
Page 60 20 cm long) would each be about right for a serving for one person, but if the amount of flesh were around 300 gr, eating one fish would be fatal.

The Marshallese fear this species and do not eat it. NOTE: Caution is necessary because in outer appearance this fish looks thoroughly edible, and since it is plentiful around atolls, it is easily caught and the opportunities for obtaining it are many.

2. Nokogiridai (Plate 11 Figure 32)

Scientific name - Gnathodentex aurolineatus Lacepede
Local name - tunar (Marshallese)
Distribution - East Indies, South Seas, Hawaii area
Morphology - Mouth small, eye large, scales small. Since this species also looks like an edible fish, care is required. Small, generally around 20-30 cm.

Toxicity. Only one specimen was tested. A cat which ate 15 gr showed symtoms of locomotory impairment milder than those caused by the preceding species. This species is thought to fall within the strongly toxic category. NOTE: There is an edible fish called kul by the Marshallese which closely resembles this species and may be mistaken for it. It is said to have a short spine on the
Tables 51, 52
Page 61 opercle and the body is slimmer. We were unable to catch one and do not know what fish it is, but note it here anyway.

Supplementary-Edible Fish of the Family Sparidae and Closely Related Fishes

1. Mejidai (Plate 11 Figure 30)

Scientific name - Gymnocranius microdon (Bleeker)
Local name - mejmej (Marshallese)
Distribution - Celebes area, Inner South Seas
Characteristics - Body thick, obscure brown line on head running through eye onto cheek. Body silvery, with a faint pinkish tinge.
NOTE: This species is nonpoisonous. It is taken abundantly at Jaluit and sold for food. The author has eaten it and found it delicious. (See animal experiment table 52, preceding paragraph)
Table 53

2. Urokosagi (Plate 10 Figure 28)

Scientific name - Gerres baconensis (Evermann & Seale)
Local name - ilimek (Marshallese)
Distribution - Philippines, Inner South Seas
Morphology- Characterized by the long projecting snout.

Toxicity. We heard of no cases of poisoning ascribed to fishes of this genus. This species is caught and sold as a food fish. An experiment was made for purposes of comparison and the results, as shown in the tables, were negative.
Page 62 Tables 54, 55

3. Kisujihimeji (Plate 10 Figure 29)

Scientific name - Mulloidichthys erythrinus (Klunzinger)
Local name - jome (Marshallese)
Distribution - Indian Ocean to Hawaii
Morphology- Two barbels on the lower jaw are characteristic of this group of fishes. This species is easily identified by its characteristic coloring.

Toxicity. Since it was reported that there had been a case of a group of people poisoned by this fish at Jabor in Jaluit atoll, we tested it in an experiment with animals. We were unable to detect any toxicity even in specimens caught only four hours previously. It is suspected that the poisoning may have been due to putrefaction in stale fish. The author was not able to examine the material in question and so wishes to reserve judgment, but in the two specimens which he tested, at least, no toxicity could be detected. It is not clear whether [Page 63] or not the jomme which Mr. Matsuo lists as poisonous is the species. A blue species resembling this one is called jo by the Marshallese and furuyK by the Okinawans; it is an edible fish and is sold in the markets.

[Page 64]

Section 8 Families Labridae and Callyodontidae

Fishes of these families occur abundantly in tropical waters, and many of them are beautifully colored. Quite a few species are found in Japanese waters also, especially in southern Japan. The number of species which occur in the South Seas is extremely large, the majority of them being just as edible as the Japanese species. Only a few are poisonous, and most of these very mildly so. Apparently little has been known hitherto of the poisonous fishes of these families.

Family Labridae

1. Yashabera (Plate 12 Figure 34)

Scientific name - Cheilinus fasciatus (Bloch)
Local name - jòllōl (Marshallese)
Distribution - Africa, Red Sea, Indian Ocean, E. Indies, Inner South Seas.
Morphology - Easily identified by its characteristic coloration.

Toxicity. Almost no effect could be detected in an experiment in which a cat ate 15.8 gr of cooked flesh. This species lives in the coral reefs and is difficult to catch. We were able, by the use of dynamite, to collect only one specimen, and so could only perform one experiment. The chances of catching this species should generally be slight.

Some Jaluit residents said that this fish is nonpoisonous while others claimed that at times it causes mild poisoning. There appears to have been no
[Table 56]
[Page 65] case of serious poisoning ascribable to this species.

Judging from the above data, we cannot call this species nonpoisonous, but consider that it is probably slightly, or at times mildly, toxic.

[Table 57]

2. Hanabibera (Plate 12 Figure 33)

Scientific name - Cheilinus sp.
Local name - labbo (Marshallese), hirōsā (Saipan Japanese)
Distribution - Inner South Seas
Morphology - The coloration of this species is characteristic, with vermilion spots and lines scattered over the head. Each of the scales on the sides of the body bears one vermilion line, and there are two vermilion lines on the dorsal and anal fins. Some individuals of this species have the posterior ends of the dorsal and anal fins, the dorsal and ventral edges and the central ray of the caudal, and the ventral fins elongated. (Figure 33-2) This is perhaps a sexual difference.

Toxicity. A cat which ate 19.5 gr showed no ill effects. Of the three mice used in the experiments, one which ate 0.3 gr of liver was unaffected while the other two showed mild to strong effects.

There was said to have been a case of poisoning at Saipan caused by a specimen of about 3.75 kg weight hooked outside of the outer reef. In the Marshalls the species was said to be poisonous at Jaluit but nonpoisonous at Mejit.

Because few specimens were available for experimentation, it was not possible to determine whether toxicity varied with the size of the fish or with the locality, but it is thought that small specimens are slightly or mildly toxic. [Page 66] Judging from the symptoms produced, it may be said that in large specimens the toxicity is no greater than the degree described in this report as "mild".

3. Kumadoribera (Plate 13 Figure 37)

Scientific name - Coris gaimardi (Quoy & Gaimard)
Local name - lükobinatat, small ones called lukub (Marshallese)
Distribution - Indian Ocean, E. Indies, South Seas
Morphology - Body extremely thin and flattened laterally. Body color glossy black in life, with an indigo spot on each scale. Indistinct dark green lines on the head.

Toxicity. This species is the most strongly toxic of the labrids. Of three mice used in testing it, only the one which ate raw flesh was not affected. Two cats were used, the one which ate cooked flesh showing strong symptoms of poisoning. The cat which ate only raw flesh was not affected, perhaps because the amount consumed was too small or perhaps for some other reason.
[Tables 58, 59]
[Page 67] The people of Jaluit consider this species poisonous and do not eat it. It is thought to be of a strong degree of toxicity.

4. Giohibera (Plate 14 Figure 39)

Scientific name - Epibulus insidiator (Pallas)
Local name - mõ (Marshallese)
Distribution - Africa, Indian Ocean, South Seas, Hawaii area
Morphology - Readily identified by its large, protrusible mouth. Ground color of body is a brownish black.

Toxicity. Only one specimen was tested, but it produced mild symptoms in both the cat and mouse. Should be considered poisonous.

The three species cited below are edible.

Family Callyodontidae

No poisonous species.

1. Aobabudai (Plate 13 Figure 35)

Scientific name - Callyodon microrhinos (Bleeker)
Local name - alowōr (Marshallese)
Distribution - E. Indies to South Seas, Hawaii area
Morphology - Teeth form a beak and are green. Scales on sides of body each with red spot. Natives say that there are individuals,,called mao, which lack the red spots. Perhaps another species closely resembling this one.

Toxicity. This species is taken by driving-in nets and by angling near the coral reefs, and large numbers are marketed. The natives use it as an article of daily diet. No ill effects could be observed in an experiment with a cat.
[Page 68]

2. Yoroibudai (Plate 13 Figure 36)

Scientific name - Callyodon pulchellus (Rüppell)
Local name - belibilikio (Marshallese)
[Plates 60, 61]
Distribution - Red Sea, Indian Ocean, South Seas
Morphology - Can be identified at a glance by the characteristic coloring.

Toxicity. No effect on experimental animals. One of the principal market fish. Some persons hesitate to eat it because it looks very poisonous in its general appearance, but the flavor is delicious.

3. Fujiirobudai (Plate 14 Figure 38)

Scientific name - Pseudoscarus sp.
Local name - ikmouj (Marshallese)
Distribution - Marshalls area

Toxicity. Nonpoisonous (not tested on animals). Sold in the market as a food fish.
[Page 69]

Section 9 Family Serranidae

The fishes of this family occur in the South Seas in great abundance and in many species. They are also fairly plentiful in the waters of southern Japan where they are all regarded as delicious food fish. In the South Seas generally, the majority of them are edible. In an area where most of the fish are non-oily, these fishes, with their white oily flesh, grace the tables of the Japanese residents under the name of tamakai.

Plentiful around coral reefs, they are mostly taken by angling. Some of the attain a very large size.

There are a number of poisonous species in this family which are often eaten by mistake because of the large number of species which resemble them.

1. Ohagurohata (Plate 14 Figure 40)

Scientific name - Cephalopholis argus Schneider
Local name - kalemej (Marshallese), kurogammo (Saipan Okinawan)
Distribution - Red Sea, Indian Ocean, Philippines, Australia, South Seas, Hawaii area
Morphology - Body comparatively flat laterally. Coloration is characteristic, th dark blackish sides having scattered small bright indigo spots with black borders The posterior half of the body also has black stripes which, although indistinct in life, show clearly in preserved specimens.

Toxicity. Experiments at Saipan with three fresh specimens produced no poisoning, the only effects noted being caused by the cooked flesh of fish which had been left for 16 hours and which had developed a stench of putrefaction. It was noted that in the latter case most of the experimental animals developed diarrhea. At Jaluit two specimens were tested, one of which produced symptoms of poisoning.

On the whole, few experiments indicated strong toxicity and only one animal died. This species should be considered mildly poisonous.

This species is abundant in coral reef areas and is easily hooked. There have been many cases of poisoning in human beings.
[Page 70]
[Tables 62, 63, 64]
[Page 71]
[Tables 65, 66]
[Page 72]
[Tables 67, 68, 69]
[Page 73]
[Table 70]
In rare cases, when large quantities have been eaten, the poisoning has been so severe that the victim could not stand up, but the majority of cases are of a mild degree. One person reported a case of poisoning as a result of eating the head, viscera, and flesh of a specimen of this species weighing 250 momme [937.5 gr]. Those who ate the flesh sliced raw were mildly poisoned. Their hands and feet stung when placed in water. They also ate the stomach, which contained some crabs which they thought caused the poisoning. Numbness spread gradually, beginning in the extremities. After this experience one victim was cured of nervous trouble and rheumatism.

According to fishermen from Okinawa, this fish is also found there and has been responsible for cases of poisoning.

2. Akajin (Plate 15 Figure 41)

Scientific name - Plectropomus truncatus Fowler
Local name - akajin, kurobaniakajin (Saipan Okinawan)

Distribution - Philippines, Borneo, Celebes, Inner South Seas
Morphology - Body a dark red-brown with small scattered dark blue spots. These are rather indistinct in large specimens. Grows very large, ordinarily about 1 meter, occasionally close to 2 meters in length.

Toxicity. Three out of 10 mice used were affected to some degree, and one died. (The animals were not tested for mild sensory impairment.)

This species also caused some diarrhea.

A case was reported of poisoning in human beings in which the fish was stewed in soy sauce and one slice was eaten for supper. During the night vomiting and diarrhea began. The next moring the victim's joints were stiff and he experienced difficulty in walking. In another case the tongue and the area around the mouth became numb and stiffened. A person who had been poisoned by this species at Okinawa recalled that it caused vomiting and diarrhea and that he felt numb for [p. 74] about a week afterward. No case was reported in which the poison was fatal [Tables 71, 72, 73]

This species is thought to be of a mild degree of toxicity, only rare cases being reported of a strong degree.

The following very similar edible fish is cited for purposes of identification.

[Page 75]

3. Yogorehata (Plate 15 Figure 42)

Scientific name - Plectropomus sp.
Local name - joanuron (a variety of jowe or joie), tamakai (Japanese)
Characteristics - Very similar to the preceding species; it can be distinguished by its larger spots. The ground color is brighter in this species. It is sold in the markets as an edible fish and is nonpoisonous. The Japanese call it tamakai and prize it as food. The flesh is white and is very good sliced and served raw or stewed in soy sauce, since it is quite oily. The word jowe or joie is used very broadly at Jaluit, being equivalent to hata or tamakai [general terms for serranids], and includes both poisonous and nonpoisonous species.
[Table 74]

4. Amadaredokuhata (Plate 16 Figure 43)

Scientific name - Plectropomus oligacanthus Bleeker
Local name - julae (Marshallese)
Distribution - Indian Ocean, E. Indies, Philippines, Inner South Seas
Morphology - The markings are distinctive, blue lines and spots on a blackish-brown ground color. On the head and back the blue lines run roughly horizontally. The spots are either scattered over the sides of the body, or form vertical rows (transversely across the body) posterior to the pectoral fin. There are horizontal lines on the soft parts of the dorsal and anal fins.

Toxicity. Judging from the results of all the experiments on animals, except in the case of a mouse which ate the liver, this species is violently poisonous.

The Jaluit natives consider this fish deadly and do not eat it. It is readily taken on hook and line and abounds near the encircling reefs, but no cases [Page 76]
[Table 75] of poisoning were reported, probably because its coloring is so distinctive.

5. Barahata (Plate 16 Figure 44)

Scientific name - Variola louti (Forskål)
Local name - kaikbet (Marshallese), akaganmo, akadei (Okinawans and Saipan Japanese)
[Table 76]
[Page 77] [Tables 77, 78]
Distribution - Red Sea, Indian Ocean, South Seas
Characteristics - Readily identifiable by its coloration

Toxicity. Of four mice used in the experiment, two which ate cooked flesh showed symptoms of poisoning. The cat regurgitated half of the amount eaten, and appeared to be poisoned. The toxicity should be considered to be of a mild or strong degree.

We know of no examples of human beings poisoned by this species.

Another species is described below which greatly resembles this one but which is nonpoisonous.

6. Azukiganmo (Plate 16 Figure 45)

Scientific name - Variola sp.
Local name - not known
Distribution - Marshalls area
Morphology - Very similar to preceding species, but the coloration is different. The preceding species has vermilion markings on a red background, while in this species the ground color is a reddish dusky brown and the spots are bright red. In preserved specimens the markings are white. The spots are larger than in the preceding species.

Toxicity. Experients with animals showed it to be nonpoisonous.

[Page 78] 7. Madarahata (Plate 17 Figure 46)

Scientific name - Serranus fuscoguttatus (Forskål)
Local name - kuro (Marshallese), ishiganmo (Saipan Japanese)
Distribution - Red Sea, Persian Gulf, Indian Ocean, Philippines, E. Indies, Outer South Seas, Hawaii area
Morphology - The coloration is complex and resembles a rock. There is some variation depending on the habitat, but the most notable characteristic is a large black saddle-shaped spot occupying 2/3 of the length of the caudal peduncle. It is especially clear in preserved specimens due to the fading of the ground color, but it can be seen in fresh specimens.

Toxicity. Animal experiments showed mild toxicity.

According to fishermen at Saipan this species also occurs in Okinawa and has been responsible for poisonings there. Large fish (over 1,875 gr) are said to be poisonous.
[Table 79]

8. Yodarehata (Plate 17 Figure 47)

[Page 79]
Scientific name - Serranus sp.
Local name - yudayamibai (Saipan Okinawans)

Distribution - Marianas, Marshalls
Morphology - The preceding species very closely resembles this species. In this species the body depths is less and the head is smaller. It also has a black spot on the caudal peduncle, but it is not as large as in the preceding species.

Toxicity. Mildly toxic.

According to Saipan fishermen this species is mildly poisonous, causing numbness in the mouth and inability to swallow the saliva. The name yudaya is said to mean "yodare drivel". The fish has never proved lethal and is commonly made into fishcake and eaten, with few cases of poisoning resulting, it is said.
[Tables 80, 81, 82]
[Page 80]
[Table 83]

9. Iwahata (Plate 17 Figure 48)

Scientific name - Serranus microdon Bleeker
Local name - illino (Marshallese)
Morphology - Resembles the preceding species, but the snout is shorter and the spots are smaller.

Toxicity. This species has been reported as poisonous under the name irinno by Matsuo (op. cit.). The writer tried to collect this fish but was unable to, so Matsuo's fish is here identified with this species and recorded as a strongly poisonous fish according to the natives. The figure is not drawn from life, but is based on the previously cited works of Matsuo and Bleeker.

10. Tsuchihozeri (Plate 18 Figure 49)

[Page 81]
Scientific name - Serranus flavocaeruleus (Lacépède)
Local name - booklum (Marshallese)
Distribution - Indian Ocean, South Seas, E. Indies, Formosa, S. Japan
Morphology - Body deep, head large, comparatively flat laterally. The ground color is pale with irregular large and small spots. It is edible and is taken for the market. It appears to suit the Japanese taste, and is high-priced. This species is also called temakai.

11. Tsuchiirohata (Plate 18 Figure 50)

Scientific name - Serranus albofasciatus (Lacépède)
Local name - lejebjeb (Marshallese)
Distribution - Marshalls area

Toxicity. Judging from the results of experiments with animals, and also from the fact that the fish is sold in the markets as an edible species without any cases of poisoning reported, this species is considered nonpoisonous. It is called tamakai by the Japanese.
[Tables 84, 85]
[Page 82]

12. Nominokuchi (Plate 80 Figure 51)

Scientific name- Serranus fario (Thumberg)

Local name - lejebjeb (Marshallese), tamakai (Japanese
Distribution - E. Africa, India, China, Inner South Seas, Philippines, Japan
Morphology - Resembles the preceding species, but has three black spots on the dorsal part of the posterior half of the body.

Toxicity. This species is also nonpoisonous. It is handled in the markets as a food fish. This fish is taken in great quantities at Jaluit in the winter. The name lejebjeb belongs properly to this species, and the preceding species is said to be a variety of it. At Jaluit this fish is well-flavored and is esteemed by the Japanese, who call it also tamakai.

[Page 83]

Section 10 Family Hepatidae

The fishes treated in this section belong to the family Hepatidae. Only a very few species of this family occur in Japan. They are small fish with tough skins and because of this, together with their strange appearance, there is apparently no place in Japan where they are used as food.

For this reason there is little chance that Japanese going to the South Seas will catch and eat these fish, however, the number of species occurring in the South Seas area is extraordinarily great, and it can be said that the majority of the fish taken by driving-in nets near coral reefs are of this family. We therefore considered it necessary to acquire some accurate knowledge in the field concerning their edibility. The natives distinguish many different species of these fish.

Since these fish live among the coral reefs, their teeth are small and numerous, being adapted to eating coral polyps.

1. Sazanamihagi (Plate 19 Figure 52)

Scientific name - Ctenochaetus strigosus (Bennett)
Local name - kushiku, kuchiku, kusaku, kusaba (Okinawan dialect used by Saipan Japanese); diebdro (Marshallese)
Distribution - Red Sea, Indian Ocean, E. Indies, South Seas, Philippines, Hawaii area, Formosa, China Sea, Okinawa.
Morphology - A characteristic of this genus is that the comb-like teeth are movable. The individual teeth are spoon-shaped with round tips.

This species has numerous fine blue horizontal lines on the sides of the body. There are indistinct yellow-brown spots on the head, and several blue lines on the dorsal and anal fins. It is a small fish around 20 cm long.

Toxicity. This species was taken in large numbers in driving-in nets. Seventeen specimens were tested in order to ascertain whether toxicity varied as between individuals. Results are shown below in tables 86–104.
[Page 84]
Of the 17 specimens, three produced no noticeable effects. Only two (No. 5 and No. 7) produced strong symptoms, and the rest were rated as mildly or slightly toxic. Fish were collected at four stations to test the natives' statement that the toxicity varies depending on the locality, but no definite variation could be demonstrated. Various organs, blood, liver, and muscle tissue were tested

separately, and the muscle tissue was fed both raw and cooked. Cooked tissues appeared to produce more cases of rather evident poisoning, but it was impossible to perceive any especially marked effect from the blood and liver.

Persons who had been poisoned by this species said that at first their mouths began to burn as if they had eaten red peppers. There was diarrhea, but no vomiting and their bodily movements were not affected.

Both the experiments on animals and the symptoms reported in human beings indicate a mild degree of toxicity for this species.

In the markets they soak this fish in ice water overnight and make it into fishcake for sale the following day, no cases of poisoning resulting from this practice having been reported.

[Table 86]

[Page 85] [Tables 87, 88, 89]

[Page 86] [Tables 90, 91]

[Page 87] [Tables 92, 93]

[Page 88] [Tables 94, 95]

[Page 89] [Tables 96, 97, 98]

[Page 90] [Tables 99, 100, 101]

[Page 91] [Tables 102, 103]

[Page 92] [Table 104]

2. Kawarisazanamihagi (Plate 19 Figure 53)

[Table 105]

[Page 93]

[Tables 106, 107, 108]

[Page 93]

Scientific name - Ctenochaetus sp.
Local name - teo (Marshallese)
Distribution - Marshalls area
Morphology - Teeth and other characteristics same as in the preceding species, but coloration differs, with small blue spots scattered over sides and head. There are about twice as many blue-brown lines on the dorsal and anal fins as in the preceding species. This species grows somewhat larger.

Toxicity. Of four specimens tested, one produced no ill effects. The other three caused symptoms of poisoning of about the same degree of severity as the preceding species. Should be considered mildly toxic.

The natives consider this a poisonous species.

[Page 94]

3. Nisesazanamihagi (Plate 19 Figure 54)

Scientific name - Hepatus bleekeri (Gunther)
Distribution - Red Sea, Indian Ocean, E. Indies, Philippines, South Seas, Hawaii area
Morphology - Coloration and form closely resemble the sazanamihagi. This species

differs in that the teeth, although ctenoid, are solidly fixed in the jawbones and do not move. Their tips also are not especially thick. The blue lines on the sides are fewer in this species, and the body is thicker (the breadth of the body is greater).

Toxicity. This is an important food fish.(Animal experiments were not performed.)

This fish is sold in the markets, and does not cause poisoning. It is cited for comparison with C. strigosus.

4. Montsukihagi (Plate 20 Figure 55)

Scientific name - Hepatus olivaceus (Schneider)
Local name - ael (Marshallese)
Distribution - Indian Ocean, N. Australia, Philippines, Formosa, Okinawa, South Seas, Hawaii area
Morphology - There are barbs on the caudal peduncle. The teeth are like those of the preceding species. There is a flame-colored horizontal mark above the pectoral fin.

Toxicity. According to the natives this species at times causes mild cases of poisoning, but it is said to be used as an article of daily diet. Mr. Matsuo listed it as a poisonous fish. By his account it appears to be slightly toxic, varying with the individual specimen, but at most of a mild degree of toxicity.

This species is taken in large numbers in driving-in nets, and is a common article of the natives' diet.

Circumstances prevented our testing it.

5. Katakurokanran (Plate 20 Figure 56)

Scientific name - Hepatus nigrofuscus (Forskål)
Local name - a variety of diebdro (Marshallese)
Distribution - Red Sea, Indian Ocean, E. Indies, Philippines, Formosa, Ryūkyūs, [Page 95] South Seas
Morphology - Resembles the preceding species, but has black longitudinal stripes above the pectorals and around the barbs on the caudal peduncle.

Toxicity. Circumstances prevented our testing this species. It is commonly used in the native diet, but is said to cause mild poisoning at times.

6. Shimahagi (Plate 20 Figure 57)

Scientific name - Hepatus triostegus (Linné)
Local name - kuban (Marshallese)
Distribution - Indian Ocean, E. Indies, N. Australia, Philippines, South Seas, Hawaii area
Morphology - This species can be readily identified by its characteristic coloration.

Toxicity. This too is a foodfish which is sold in the market. There have

been no cases of even mild poisoning caused by it, as there have with the two preceding species, and it has never been cited as a poisonous fish. The flavor is good, its only defect being that it spoils easily and is inedible after 5 - 6 hours at the atmospheric temperatures of the South Seas.

7. Raidenhagi (Plate 21 Figure 58)

Scientific name - Zebrasoma veliferum (Bloch)
Local name - laid, means "lightning" (Marshallese), igogasa (Saipan Japanese, Okinawan dialect, means "itching leaf"), hirenagahagi (Japanese nickname)
Distribution - Red Sea, Indian Ocean, E. Indies, Philippines, South Seas, Hawaii area
Characteristics - Coloration and long dorsal and anal fins.

Toxicity. Of four specimens (one from Jaluit, three from Saipan) tested, three appeared to be slightly poisonous. Some Okinawan fishermen residing at Saipan say that eating the skin of this species makes the mouth itch, but that the flesh may be eaten without any ill effects. Others say that eating the flesh also makes the mouth itch, but without any other effect on the body. They say that [Page 96] this fish produces the same reaction at Okinawa. According to the natives of Jaluit, this fish does not poison but only makes the mouth burn.
[Translator's note: The word "kayui" properly means "itching", but it is suspected that as used in this connection by Okinawans it may mean "stinging" or "burning".]
In any case, this fish is probably slightly poisonous.
[Tables 109, 110]
[Page 97 Tables 111, 112, 113]

8. Tsumaritengu (Plate 21 Figure 59)

Scientific name - Naso brevirostris (Valenciennes)
[Page 98]
Local name - batoklaj (Marshallese)
Distribution - Red Sea, Indian Ocean, E. Indies, Philippines, South Seas, Hawaii area
Morphology - Has a protruding horn on the nose almost on a level with the eyes.

Toxicity. This is a useful foodfish. It is seen in large numbers in the markets, and forms a large part of driving-in net catches.

[Page 99] Section 11 Families Monacanthidae and Balistidae and Others

The fishes treated of in this section belong to the families Monacanthidae and Balistidae.

Several species of both of these families occur in Japanese waters, but except for some of the monacanthids they are rarely taken and there are few areas where they are used for food.

In the South Seas numerous species occur, including some poisonous ones.

Balistidae

1. Akahamongara (Plate 22 Figure 60)

Scientific name - Odonus niger (Ruppell)
Local name - bub or bub mej (Marshallese)
Distribution - Indian Ocean, tropical Western Pacific
[Tables 114, 115]
[Page 100]
Characteristics - Body black, dorsal and anal fins slightly bluish. The red teeth are characteristic.

Toxicity. Results of experiments indicate strong toxicity. Some residents of the Marshalls said it was poisonous, some said it was nonpoisonous, and some did not know. This species appears to be rarely taken and there seems to be no certain knowledge concerning its toxicity.

The name bub is a general term for the Balistidae and also includes edible fishes.

2. Kiberimongara (Plate 22 Figure 61)

Scientific name - Balistes flavimarginatus Rüppell
Local name - lele (Marshallese)
Distribution - Indian Ocean, tropical and subtropical W. Pacific
Characteristics - Easily recognized by the coloration.

Toxicity. This species is nonpoisonous, and is treated as a foodfish in the Marshalls area.
[Table 116]
[Page 101] [Tables 117, 118]

3. Mongarahagi (Plate 22 Figure 62)

Scientific name - Balistes conspicillum Bloch & Schneider
[Page 102]
Local name - bub
Distribution - Roughly the same as the preceding species
Characteristics - The coloration is unique.

Toxicity. Matsuo (op. cit.) has recorded this species as poisonous with the name holeketem bub. The natives say that in Marshallese holeketem means "fish-poisoning". Matsuo classed it with the fatally poisonous species. This writer had no opportunity to test it on animals, and merely cites it here.

Monacanthidae

Hoshinamihagi (Plate 23 Figure 63)

Scientific name - Aleuteres scriptus Osbeck
Local name - sensuru (Saipan Japanese; Okinawan dialect)
Distribution - W. Indies, Indian Ocean, E. Indies, Inner South Seas

Morphology - The coloration and markings are characteristic. In life it is colored as shown in the upper figure, but after death and as seen in the markets it looks like the lower figure. They are drawn side by side for comparison.

Toxicity. This species gave no indication of toxicity in experiments.

Saipan fishermen say that the flesh of this species may be eaten, but that if the intestines are fed to pigs, the pigs die. In our experiments the animals would not eat the intestinal contents and consequently it was impossible to determine their effect.

Chaetodontidae

Kihachijō (Plate 25 Figure 69)

Scientific name - Holacanthus diacanthus Günther
Local name - jorur (Marshalls area)
Distribution - Indian Ocean, E. Indies, South Seas, Hawaii area

Toxicity. This species belongs to the family Chaetodontidae and is not taken in large quantities.

Residents of the Marshalls apparently do not know whether or not it can be [Page 103]eaten. Results of experiments indicate that it may be slightly poisonous (Table 121).

Pomacentridae

Kobansuzumedai (Plate 25 Figure 70)

Scientific name - Abudefduf sexfasciatus (Lacépède)
Local name - bakej (Marshallese). Another slimmer-bodied species is called urel.
Distribution - Red Sea, Indian Ocean, South Seas, E. Indies

Toxicity. From results of experiments with animals, this species appears to be very slightly poisonous.

Residents of the Marshalls have no certain knowledge concerning the toxicity of this species because it is a small fish (about 5 cm) and is not eaten.

This is a variety of the fish called aobiki, which is used as live bait in the skipjack fishery.
[Tables 119, 120]

[Page 104]

Section 12 Family Tetraodontidae

The toxicity of the tetraodonts has long been known, and many studies have been made of them. Those which up to the present have been known to be poisonous are, according to Fukuda (op. cit. p. 18), the mafugu, higanfugu, mefugu, komonfugu, shosaifugu, akamefugu, kusafugu, torafugu, shimafugu, and gomafugu.

There are several reports from the Philippines among the past literature of South Seas tetraodonts. Herre* has, for example, reported Tetraodon immaculatus Bloch & Schneider, T. reticularis Bloch & Schneider, and T. fluviatilis Buchanan-Hamilton as poisonous in the Philippines. Seale ** has described the poisonous fish called tinga-tinga (Moro dialect) or botete, and identified it as Spheroides sceleratus (Forster). He has further recorded three species of the Diontidae, called loco (in Tagalog botiting laot), of the Philippines as poisonous, and seven species of the Balistidae (called papaco) and some species of the Monacanthidae (called pacol) as suspected of being poisonous.

The author, thinking that the possibility of poison would probably be taken into consideration whenever tetraodonts were eaten, did not try in the course of this investigation to collect and test them to as great an extent as he did in the case of the species which resemble other edible fishes. Consequently, he can only deal with a very few species.

1. Yokoshimafugu (Plate 23 Figure 64)

Scientific name - Tetraodon hispidus Linne
Local name - wat (Marshallese)
Distribution (Red Sea in the west, Indian Ocean, throughout South Seas, Okinawa in the north, east from Hawaii to Panama.
Morphology - Longitudinal stripes consisting of alternate black and white lines on the belly. Some have the area around the ventral fin and opercle black surrounded by white stripes forming incomplete rings. On the dorsal surface of the body and on the caudal fin are small white spots scattered over a black ground. [Page 105]

Toxicity. No poison was detected in the muscle tissue. The liver appeared to be slightly poisonous.
[Table 121]

2. Mizorefugu (Plate 24 Figure 66)

Scientific name - Tetroaodon meleagris Bloch & Schneider
[Table 122]
[Page 106]
Local name - not known
Distribution - tropical Pacific
Morphology - Body dusky brown, small white spots scattered over whole body, somewhat smaller on the back than on the belly. Spots also on all fins except the pectorals.

Toxicity. Only the liver was tested, and only a slight toxicity could be detected.

3. Yogorefugu (Plate 23 Figure 65)

Scientific name - Tetraodon nigropunctatus Bloch & Schneider
Local name - wat (Marshalls area)
Distribution - E. Africa to Samoa

* Herre: Philippine Journal of Science, Vol. 25, No. 4. p. 416-510. 1924
** Seale: ibid. Vol. 7, No. 4, p. 289-291. Some poisonous Philippine fishes.

Morphology - Coloration varies widely. Some specimens are yellow (as in Fig. 65), and some are brown, both varieties having small irregular black spots scattered over the body. The posterior edges of all fins are white.
[Table 123]
[Page 107]
[Table 124]

Toxicity. The liver appears to contain poison.

[Page 108] Section 13 Addenda

In the foregoing sections the author has been able to record a total of 46 species of poisonous fish, including three species of tetraodonts, but it may easily be imagined that this does not exhaust the number of poisonous fishes occurring in the Marianas and Marshalls.

Those clearly identified species which have in the past been reported as poisonous either in the literature or in popular tradition have all been recorded in the preceding sections, regardless of whether or not we collected and tested them, however, there remain a number of poisonous fishes which we were unable to take and whose identity is uncertain, or which we were unable to test and concerning the toxicity of which suspicion exists. By citing them here we intend to supplement the various sections of this chapter and complete the mention of all of the poisonous fishes of the South Seas area.

For the poisonous fishes of the Marshalls area, as noted in Section 2 of Chapter I, Matsuo has made a detailed report, recording the names of 36 poisonous species as given by the natives. Of these, 23 have been definitely recognized as included in the present report. Among the rest there are probably some which are included under different names. (In the Marshalls the names differ in the Ralik and Ratak chains, and it is hard to identify the species when it is not known which name has been used) This group will be taken up first. Tentative identifications have been made of two or three by reference to the accompanying photographs. In the case of two or three others we asked many natives, using the names given, and they were unknown to them. In other cases, however, they were able to give us a general account of the appearance of the fish. There are some other species commonly said to be poisonous which were not listed by Matsuo, and they are recorded in this section as follows:

1. aujbak

Judging by the accompanying photograph this is thought to be the akaeso, Synodus variegatus. Natives interviewed by the author did not know that this was a poisonous species. Matsuo gives it as violently and fatally toxic. We were not able to collect it and so could not test it.

It is recorded here as doubtful.

2. ikuit

When Marshallese natives were shown natural color plates, they identified this with the hiodoshihata, Epinephelus leopardus. The fish reported by Matsuo has several alternate yellow and black lines on the scales, differing in this respect from the hiodoshihata identified by the natives. The hiodoshihata is

nonpoisonous at Jaluit, and we have not heard of its being [Page 109] poisonous elsewhere. The writer has himself eaten a rather large amount (about 300 gr) of this fish stewed in soy sauce, and found it tasty and with no bad effects. Matsuo rates it as moderately poisonous.

3. jarewõd

None of the natives questioned by the writer knew what kind of a fish this was. Matsuo says that it is a small pan inar (akamasu). The pan inar is the futatsuboshidokugyo, but it is not clear whether we are dealing here with the young of this species or with a different species. Perhaps it is a lutjanid.

4. jawe elik

Elik means "small". Jawe is a general name for the Serranidae, corresponding to the Japanese hata or tamakai. It is consequently not clear what species is meant, but the natives say that it is the same as the lemejne mentioned below. However, they say that this species is edible. Others said that they knew nothing of the toxicity of the lemejne because it is rarely caught. Matsuo says that this fish is a small lemejne and has three black transverse stripes. He rates it as mildly toxic and the lemejne as moderately so. It is not clear whether or not these are the same species under different names, but in any case it is certain that they are serranids.

5. jebeb pako

Pako is a general term for sharks. From what the natives say, this is clearly the hammerhead shark. When asked whether it was poisonous, they said that they did not know because they never ate it. Matsuo says that it is traditionally considered poisonous, but that it is rarely taken.

6. jidjidbein

The natives say that this is a variety of julae and a rare fish. The julae is Plectropomus oligacanthus Bleeker. Matsuo describes it as reddish with three longitudinal lines on the head and several such lines on the body. It is difficult to imagine what kind of a fish this might be, but it is certainly a serranid. It is rated as moderately poisonous.
[Page 110]

7. jomme

From Matsuo's description this must be one of the Mullidae. The species could not be determined, but the fishes of the family Mullidae studied by the writer were nonpoisonous. Matsuo says that it is mildly toxic.

8. johe pako

According to Matsuo, "a shark without teeth and with red spots as big as the ball of the thumb." The natives know nothing of it. Said to be mildly toxic. Species not known.

9. katõk

The natives say that this is a kind of jalia (Lethrinus

miniatus). Matsuo says that it resembles the mameni [Lethrinus sp.] but the head is shorter, and rates it as moderately toxic. The natives also say that this fish is poisonous. The species is unidentified, but it probably belongs to the genus Lethrinus.

10. Kalaolap

According to Matsuo this fish is like the illino (Serranus microdon, Section 9), but has black spots on the caudal fin and on the middle section of the back. He rates it as moderately toxic. The natives say that it resembles the kuro [Serranus fuscoguttatus], but that it is not poisonous. It is certainly a serranid, but the species is unidentified.

11. lemejne

A serranid, judging by Matsuo's photograph but the species is unknown. He rates it as moderately toxic.

12. poran

Said to be a kind of ray with a poison spine on the tail. Probably should be classed as a poison-spined fish. The following definitely fall into this category.

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Hö (hanaminokasago, see the following section) and nö (seppariokoze, see the following section).

Yasukawa (op. cit.) reported nine species from Saipan under their native names. These have all been collected and tested, and the results have been set forth in preceding sections for this chapter.

Popular legend also includes the isomaguro, the isobonmo, and others among the poisonous fishes. At Saipan, Ponape, and Jaluit we heard that these species, although commonly used as foodfish, are sometimes poisonous. We did not collect nor test them, but cite them here, urging caution. Sadanosuke Miura* says that a fish called the hoshimaguro, which resembles the bachi [Parathunnus sibi (Temminck & Schlegel)] and which has beautiful stars on its sides, is taken mixed with skipjack. Kishinouye** has reported that Gymnosarda nuda (Günther) is called isomaguro in Ogasawara and tokakin in the Ryūkyūs. It is presumed that the fish generally called isomaguro by Japanese in the South Seas is probably this species.

[Page 12]

Section 14 Venomous Fishes, Poison-spined Fishes, and Poison-spined Shellfish

As explained in the introduction, the distinction between fishes which are poisonous when eaten and those which poison by biting or piercing has not always

*Miura, Sadanosuke. Fishes of the South Seas [Nankai no Sakana], Seba [畝傍] shoten, 1941.
**Kishinouye, Kamakichi. Proceedings of the College of Agriculture, Tokyo Inperial University, p. 426. 1923.

been maintained. They have, as previously noted, sometimes been confused in the literature.

Since in actual practice it is sometimes necessary to have some practical knowledge of venomous and poison-spined fishes, the following notes are added here as a warning to the reader.

Pawlowsky (op. cit.) cited the moravs as venomous and reported that their teeth contain a poison, but no later authorities appear to have detected it. The teeth of these fishes are hinged, as described in Section 1, and their points are sharp. When a person is bitten, he instinctively pulls his hand away and as a result in most cases the wounds are not merely the toothprints but are usually enlarged in the form of linear gashes.

It is thought that either the size of the wounds, or the fact that the form of the fish and the structure of its teeth resemble those of a snake has given rise to the theory that it is venomous.

In the past many species have been reported to have poisonous spines, but only those which are liable to cause trouble in the South Seas area are cited here.

1. Many species of scorpaenids have a strong spine on the dorsal with a poison gland at its base. These fishes often burrow into the sand in shallow waters near shore, and there have been many cases in which persons have stepped on them with bare feet, the wound often being fatal. The sepparickaze, Scorpaenopsis diabolus Bleeker, (nō in Marshallese) (Fig. 67) is one of the most violently toxic and also one of the most commonly occurring species of this group.

The hanamikasago, Pterois volitans (Linnaeus) (hō in Marshallese) is a fish which is found swimming around the coral reefs. It has a strong venom on the spines of all of its fins. (Fig. 68)

2. The fishes of the aigo family [Siganidae] are not as toxic as the species mentioned above but they are more commonly encountered. These too have poison glands on the spines, the structure of which has been studied by Professor Ikusaku Amemiya (op. cit. p. 8). The species cited here, the majiriaigo, Siganus puellus (Schlegel), is one which occurs abundantly in the South Seas. [Fig. 71].

This is one of the most common foodfishes. It is called aikitoker [Page 113] (Marshallese, Radak) and annan (Marshallese, Ralik), and is taken in large numbers in driving-in nets and sold in the markets. Care must be taken in handling it.

The following concerns poison-spined shellfish. All of those listed below belong to the genus Conus, and are abundant in shallow water near shore. Since their appearance is attractive, people often pick up the living animals with their hands and in so doing get stung. The piercing mechanism is not clearly understood, but the poison is violent. The sting leaves a hole like that pierced by a needle, and a space around it as large as a copper penny turns purple. The venom spreads through the body rather rapidly, and cases are known in which death resulted less than an hour after being stung. The following list is

arranged according to the presumed strength of the venom.

1. *shiroanboina*, *Conus tulipa* (Linné) (Fig. 74)
2. *amboina*, *Conus geographus* (Linné) (Fig. 73)
3. *tagayasanminashi*, *Conus textile* (Linné) (Fig. 75)
4. *tsuboimo*, *Conus aulicus* (Linné) (Fig. 76)
5. *nishikiminashi*, *Conus striatus* (Linné) (Fig. 77)

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Section 1 Symptoms

The symptoms of poisoning which appear when the toxic material is administered by mouth have been generally observed in the results of the various experiments and in the popular accounts of cases of accidental poisoning detailed above, however, although we heard of such cases we had little opportunity to see them ourselves. Consequently we have interviewed doctors in the area studied and have personally questioned victims of fish poisoning to assemble the information presented below.

Of course all of the 45 species described above do not produce the same symptoms, nor is it assumed that the toxic agent is the same in all of them, but there are certain effects generally common to all.

In most cases the following symptoms are encountered. Directly after eating, the stomach feels upset and the patient vomits. In experiments with animals many of the cats showed this symptom. Even when the flavor is good and no ill effects are felt while the fish is in the mouth, after from 30 minutes to 2 hours the inside of the mouth, the lips, and the stomach feel abnormal. The lips and mouth either feel hot, as if red peppers had been eaten, or they itch, and the stomach feels oppressed.

After a little more time has passed, numbness sets in, generally around the lips, tongue, inside of the mouth, anus, etc. Many persons also say that the skin of their hands and feet had no feeling. Others say that their hands and feet hurt when placed in water.

In the experiments, animals affected to this degree did not react by withdrawing their feet when they were pricked with a dissecting needle. We were able to detect a mild degree of poisoning by observing the reactions to pricking of various degrees of severity.

More strongly affected cases generally suffer impairment of their movements, and in some the hearing is affected, while others drivel, unable to swallow their saliva. In severe cases the patient is unable to stand or walk, and in the most serious cases respiration becomes difficult, the pulse is erratic, and death results. Most deaths occur after from 5 to 24 hours.

Impairment of the ability to walk was clearly perceived in the experiments with cats. In cases of severe poisoning the cat's hind quarters gave way and the animal could not stand up even when lifted onto its feet (photograph 3). In milder cases the animal, when forced to walk, would stagger erratically. [Page 115] These observations were used to evaluate the symptoms of poisoning (photographs 1 and 2). Mice similarly affected crawled on their bellies (photograph 4).

In many cases these symptoms were accompained by diarrhea. Some persons reported being cured of roundworms and feeling better than ever afterwards. This occurred with the akadokutarumi [Lutjanus vaiguensis] and the dokuutsubo [Gymnothorex flavimarginatus]

Cases were also reported in which headaches, dizziness, and so forth were experienced.

There were cases in which the patient, before dying, suffered a nervous disturbance, as if he were going mad, and threshed around in the bed (in several examples where the dokuutsubo [Gymnothorax flavimarginatus] was eaten). No cats or mice were observed behaving in this way when they died, most of them dying stretched out on their sides (photograph 3 and 5).

Mild cases recover completely in from 10 to 24 hours. In those which have eaten strongly toxic fish with grave symptoms resulting, sensory impairment sometimes persists for a week or 10 days.

Some persons who had eaten dokuhiraaji [Caranx melampygus] and ohagurohata [Cephalopholis argus] reported that rheumatism and nervous diseases, which they had had previously, were cured by the experience.

[Page 116] Section 2 Treatment

The best treatment is an emetic administered immediately after eating. Washing out the stomach is also effective. Where some time has passed, a laxative should give good results, and, as a treatment for paralysis, stimulants and drugs which stimulate the heart will probably be effective.

The following are some popular remedies. In these areas where many species of poisonous fish occur, the residents always have antidotes ready, and the most commonly used one is a plant called monpanoki, the scientific name of which is Messerschmidia argentea Linné (Fig. 72).

The areas in the Marianas and Marshalls where the writer made this study are separated by thousands of kilometers of ocean, yet, in spite of the fact that the natives do not travel back and forth between the that the languages are altogether different, and that Japanese fishermen do not operate in the area and consequently could not have taught them its use, the same parts of the same plant are used in the same way in both areas.

In Okinawa, also, the identical plant, there called hamasōki or meganenoki (because the wood is used for the frames of diving goggles), grows wild along the shore, and the custom exists of roasting the fried leaves and the bark of the trunk and using them as an antidote for fish-poisoning. Fishermen from Okinawa operating in the South Seas area are said always to carry in their boats a bundle of the stems of this plant, which grows wild everywhere in the area, cut into about one foot lengths and bound together like firewood.

The Marshallese natives call this plant gannatto. In this area, too, it grows wild along the shore and is easy to obtain. These people pound up the raw leaves with coral and eat them without further preparation. On some islands they are said to gnaw the bark off the stems. Some of the Japanese fishermen roast the leaves before using them.

The monpanoki grows abundantly everywhere around the shores of the islands, and there is probably no area in the South Seas where poisonous fish occur

where this plant is not found. It is a shrub, attaining a height of about two meters. The leaves are thick and covered with hair, giving them a velvety texture. It is shaped like a loquat tree, and the flowers are so inconspicuous that the writer did not notice them. See figure 70. (The color of the leaves is taken from a pressed specimen.)

The writer tried to feed this herb to animals which showed symptoms of poisoning, but they refused to eat any of it.

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Some Okinawan fishermen also say that chewing raw eggplant has a medicinal effect. They also recommend taking chestnuts which have been ground in a mortar and mixed with water to cause diarrhea. The juice pressed from pounded leaves of the kamachiri* plant is likewise said to cause diarrhea, thus lessening the effect of the poison.

These Okinawan fishermen also recommend licking lard and drinking grease.

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*kamachiri: The name kamachiri is generally used throughout the South Seas, but Mr. Naoshi Tsuyama informs me that this word is of Spanish origin, the Japanese name being kinkimoku, scientific name Pithecolobium dulce. This tree has compound leaves and thorny branches and is abundant in the South Seas.

Section 1 Toxic Substances

The following is a discussion of what we were able to learn concerning the toxic substances in the various poisonous fishes recorded in preceding sections.

Previously Yasukawa (op. cit.) experimented on the assumption that the poison was bacterial in nature, and reported negative results.

Matsuo expressed the opinion that it was similar to the poison found in tetraodonts.

In the various experiments with animals reported in Chapter III of this paper, the strength of the poison was not in most cases affected by heating at 100° C for 20 minutes. Furthermore, in the experiments with extracts reported below it was clear that the poison persisted in preparations made with absolute alcohol. From these facts it is not difficult to deduce that the poisons in the various species discussed in this paper are chemical in nature.

Since the chemical analysis of this poison was not the main objective of the present study, the author, as explained below, merely experimented to find a method of making extracts of the poison, as necessary in eliminating it, and also to discover methods of transporting material from the field for later study.

Facilities and supplies for chemical experiments were almost unobtainable in the field, and our preparations were inadequate, consequently, except in a very few cases, we preserved the materials and performed our experiments in Japan.

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Section 2 Location of the Poison and Changes Resulting from Preparation for the Table

Let us consider the localization of the poison in the body of the fish. In feeding experiments with animals the author tested each organ, insofar as they could be divided. The muscle tissues, too, were tested in various sections and an attempt was made to compare their effect.

No definite results were obtained from these experiments, that is, we could not detect anything like the limitation of the poison to any particular organ. In the case of the blood, ovaries, liver, and so forth, because the materials were given by mouth, the amounts eaten varied, and consequently the effect also varied. Comparing these organs with the muscle tissue, in most cases the latter was eaten in larger quantities and, contrary to expectation, produced more clearly marked poisoning. It should also be noted that most of the reported cases of accidental poisoning resulted from eating muscle tissues.

From this it is clear that muscle tissues taken from the fish and prepared for the table in the most ordinary manner will contain poison. It may be imagined that such material will still have blood remaining in the capillaries. If the

blood contains a concentrated poisonous substance, it is only natural that such muscle tissues will cause poisoning.

The author made many experiments, cooking the fish just as if it were being prepared for ordinary table use, in order to find out whether the toxicity would be affected. The results are shown in the various animal experiments in Chapter III. As explained in the introduction, the method used was a very simple way of applying heat to the fish. It not only showed no signs of diminishing the toxicity, but rather increased the incidence of poisoning. This agrees with the accounts of accidental poisoning in human beings, most of the cases having been caused by cooked fish. The greatest number of poisonings appear to have resulted from such preparations as fish soup, while eating the fish raw produced the fewest cases. In one family which ate fish soup, those who drank the soup were poisoned while those who only ate the pieces of fish from the soup were not. These facts perhaps indicate that the poison is resistant to heat but soluble in water. In not a few cases experimental animals ate the raw flesh without exhibiting any ill effects, but began vomiting immediately after eating flesh cooked in water and fed to them together with its juices.

From all of this it is clear that poisonous fish should not be eaten even when cooked.
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Several specimens which were broiled directly over the fire also showed no lessenings of toxicity. Although there are comparatively few cases of accidental poisonings caused by broiled fish, this is probably due to some other reason. Fish suspected of being poisonous should not be eaten broiled either.

Specimens prepared as dried fish, as explained in a later section, also showed no loss of toxicity.

As shown above, not one of the fishes prepared by various ordinary methods showed any loss of toxicity when tested on experimental animals.

Methods of eliminating the posion will be taken up again in a later section.
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Section 3 Methods of Extraction

The following experiments on methods of extracting the posion were performed by the author in the field.

Ten gr of raw muscle tissue from the fish to be tested was left for 72 hours in 100 cc of absolute alcohol. After filtering, the solution was heated and concentrated over an alcohol lamp until the odor of alcohol disappeared. Distilled water was added to make 100 cc and the extract was injected subcutaneously *. The results are shown in the following table. In no case was there any effect. Attempts were made to prepare a more concentrated fluid, but circumstances made this impossible and we were consequently unable to determine the lethal amount.

*In addition 10 gr of the same raw flesh with 100 cc of water added was cooked over an alcohol lamp, cooled, filtered, the filtrate thinned to 100 cc with distilled water, and the resulting extract was injected subcutaneously into mice. In no case did it have any effect.

These results indicate that the amount of poison in the tissues of the fish tested was very slight. It is regrettable that more virulent species were not selected.

Mouse	Date	Fish Used	Amt. Injected	Result
red-tagged spotted	Sept. 19	yodarehata flesh	0.2 cc	no apparent effect
"	"	"	"	"
spotted, untagged	"	ohagurohata flesh	"	"
"	"	"	"	"
red-tagged white	"	fuedokutarumi flesh	"	"
"	"	"	"	"
white, untagged	"	yodarehata liver	"	"
"	"	"	"	"

Extracts were prepared for comparison as follows using salted dried specimens. The same test material was used in all cases.

(1) 200 cc of water was added to 10 gr of pulverized dried salted tissues and the mixture was heated at 100° C for about two hours. After filtering it was concentrated to 15 cc (0.66 gr of dried tissue to 1 cc of fluid injected). The results of this experiment (Preparation No. 1) indicates that 0.33 gr of flesh is a lethal dose (calculated for a mouse of 15 gr bodyweight).

(2) 10 gr of the same tissue was placed in 200 cc of absolute alcohol and left for about 15 hours at room temperature (30° - 32° C). After filtering, 15 cc of distilled water was added, it was heated at 100° C to evaporate the alcohol, and after two hours was concentrated to 2.7 cc (3.7 gr of dried salted tissue to [Page 122] 1cc). Results of these experiments (Preparations No. 1, 2, and 4) indicated a lethal dosage of 0.2 gr of flesh for Preparation No. 2 and of 1.0 gr for Preparation No. 4 (calculated for a mouse weighing 15 gr).

(3) 200 cc of water was added to 10 gr of the same tissue and it was left in a refrigerator at ≠ 10° C for 15 hours. After filtering, the filtrate was heated at 100° C for about 4 hours and concentrated to 13 cc (0.77 gr of tissue to 1 cc). The results of this experiment (Preparation No. 3) did not indicate the lethal dosage but it appeared to be greater than 0.23 gr of tissue, and, judging by the symptoms exhibited, it is probably more than twice that amount.

[Tables for Preparations Nos. 1 and 2]
[Page 123] [Tables for Preparations Nos. 2', 3, 4]
[Page 124] [Tables for Preparations Nos. 5, 6, and 7]
[Page 125] [Tables for Preparations Nos. 8, 9, and 10]
[Page 126] [Two tables of experiments on cats]

The tissues remaining after filtration of these various preparations were fed to cats with no ill effects, as shown in the above tables, indicating that the amount of poison remaining in the tissues was small.

The symptoms of poisoning observed in these injection experiments were very similar to those seen in the experiments in which the toxic materials were administered by mouth.

As explained in the following section on "preservation", dried barracuda and lampreys from Japan were used as controls (Preparations Nos. 6 and 7). The lethal quantity, as indicated by these tests, differed by 200 to 300 percent from that of the dried salted specimens.

The akajin [Plectropomus truncatus] was shown by the feeding experiments reported in Chapter II to fall in the mildly toxic category. Injection experiments using strongly or violently toxic species would probably show even greater differences.

The experiments reported above indicate that for extracting the poison Method No. 2, employing alcohol, is the best.

[Page 127] Section 4 Preservation of Toxic Substances

Since the investigation of these poisons must be carried on in distant tropical areas where facilities and supplies for chemical tests are hard to obtain, the best thing to do is, if possible, to preserve the toxicity of the materials and transport them back to Japan. Several methods of accomplishing this were tried, and they are introduced here for the information of those who may study these poisons at a later time.

1. Canning and bottling

Since the poison resists a temperature of 100° C, sterilization by heating is possible. If, therefore, facilities are available, preservation by canning or bottling will be convenient. The author tried this, but the technique was faulty and the material became useless through putrefaction.

2. Salting and drying

Muscle tissues were sprinkled with salt and dried in the sun, the drying being continued for several days in strong sunlight. These materials were taken back to Japan where after about nine months they were used in experiments with the results shown in the tables (Preparations Nos. 1, 2, 3, and 4). It was not possible to tell how much their toxicity had been diminished by preservation because there were no records of tests made with the raw flesh, but comparison with the controls indicated that some of the toxicity at least was retained.

3. Preservation in alcohol

Fresh tissues were placed in absolute alcohol in a tightly covered wide-mouthed jar, and were kept for nine months after which they were used in experiments with the results shown in the table (see Preparation No. 10). The

Preparation No. 1   10 gr of pulverized salted dried tissues of the <u>akajin</u> [<u>Plectropomus truncatus</u> Fowler] with 200 cc of water added, boiled for approximately 2 hours at 100°C, filtered immediately, further concentrated to 15 cc

Mouse No. (Weight)	Date and Time of Injection	Where Injected	Amount Injected	Corresponding quantity of Tissue	Results
No. 13 (13 gr)	1630 July 11	subcutaneous	0.2 cc	0.13 gr	no effect
No. 14 (12 gr)	"	in abdominal cavity	0.7 cc	0.46 gr	1900 July 11 could not walk straight 0700 July 12 died
No. 15 (18 gr)	1640 July 11	"	1.0 cc	0.66 gr	1900 July 11 could not walk straight 0700 July 12 moribund, lying still 1000 July 12 died
No. 1 (13 gr)	"	"	0.5 cc	0.33 gr	1900 July 11 movements affected 0900 July 12 died
No. 2 (16 gr)	1645 July 11	"	"	"	1900 July 11 walking affected 0700 July 12 walking still impaired 1300 July 12 back to normal
No. 5 (13 gr)	1630 July 11	subcutaneous	0.3 cc	0.2 gr	1900 July 11 walking unaffected 0700 July 12 some reaction noted 1300 July 12 moribund 1400 July 12 died
No. 6 (16 gr)	"	"	0.4 cc	0.26 gr	1900 July 11 no effect no effect thereafter
No. 7 (13 gr)	"	"	"	"	0700 July 12 some effect noted 1300 July 12 movements affected 1125 July 13 died

Preparation No. 2 10 gr of pulverized salted dried tissues of the akajin [Plectropomus truncatus Fowler] , 200 cc of absolute alcohol added, left for 15 hours at room temperature (30 - 32°C), then the clear fluid decanted, 155 cc of water added, heated at 100°C until alcohol evaporated, reduced to 2.7 cc after 2 hours

Mouse No. (Weight)	Date and Time of Injection	Where Injected	Amount Injected	Corresponding Amount of Tissue	Results
No. 24 (13 gr)	0955 July 12	in abdominal cavity	0.2 cc	0.74 gr	1000 July 12 some reaction noted 1130 July 12 died
No. 23 (13 gr)	"	subcutaneous	"	"	1130 July 12 moribund 1210 July 12 died
No. 22 (12 gr)	0900 July 12	"	0.1 cc	0.37 gr	1130 July 12 somewhat weakened 0700 July 13 normal
No. 21 (14 gr)	"	"	0.3 cc	1.11 gr	1000 July 12 some reaction noted 1135 July 12 died
No. 24 (13 gr)	0950 July 12	"	0.2 cc	0.74 gr	1130 July 12 some reaction noted. The animal recovered somewhat in the evening, but was found dead at 0900 July 13

Preparation No. 2' an equal quantity of sterile water added to 1.5 cc of Preparation No. 2

Mouse No. (Weight)	Date and Time of Injection	Where Injected	Amount Injected	Corresponding Amount of Tissue	Results
No. 36 (9.5 gr)	1040 July 12	subcutaneous	0.05 cc	0.09 gr	no noticeable effect
No. 34 (16 gr)	"	"	"	"	"
No. 33 (10.5 gr)	"	"	0.1 cc	0.018 gr	"

Preparation No. 3 10 gr of pulverized salted dried tissues of the akajin [Plectropomus truncatus Fowler] with 200 cc of water added, left for 15 hours at / 10°C, filtered, heated for approximately 4 hours at 100°C and concentrated to 13 cc

Mouse No. (Weight)	Date and Time of Injection	Where Injected	Amount Injected	Corresponding amount of Tissue	Results
No. 28 (11.5 gr	1130 July 12	subcutaneous	0.1 cc		no noticeable effect
No. 27 (11 gr)	"	"	"		1520 July 12 moribund 1600 July 12 died
No. 26 (14 gr)	1135 July 12	"	0.2 cc		no noticeable effect
No. 25 (14 gr)	"	"	0.3 cc		July 13 somewhat listless 1300 July 14 found dead

Preparation No. 4 10 gr of pulverized dried flesh of the <u>dokuutsubo</u> [<u>Gymnothorax flavimarginatus</u> Rüppell] left in 100 cc of absolute alcohol for 20 hours at room temperature (30-32°C), 15 cc of water added to the filtrate, heated for about 50 minutes at 100°C until alcohol disappeared, concentrated to 4 cc, equal quantity of ether added, fat washed out, 9 cc of water added

Mouse No. (Weight)	Date and Time of Injection	Where Injected	Amount Injected	Corresponding Amount of Tissue	Results
No. 37 (16 gr)	1030 July 18	subcutaneous	0.1 cc	0.8 gr	no effect
No. 38 (16 gr)	"	"	0.2 cc	1.0 gr	1400 July 21 movements affected 1730 July 21 died
No. 38 (16 gr)	"	"	0.3 cc	2.4 gr	1300 July 21 some effect noted 1700 July 21 died

Preparation No. 5   10 gr of flesh from the back of a 130 cm specimen of Gymnothorax flavimarginatus Rüppell which had been preserved in 10% formalin for about 9 months was broken up in 200 cc of absolute alcohol and left for 20 hours at room temperature (30-32°C). The filtrate with 20 cc of water added was heated for 8 hours at 100°C until the formalin and alcohol were driven off and it was concentrated to 8 cc. As it was turbid, it was again filtered before using.

Mouse No. (Weight)	Date and Time of Injection	Where Injected	Amount Injected	Corresponding amount of Tissue	Results
No. 49 (23 gr)	1130 July 18	subcutaneous	0.3 cc	0.36 gr	1700 July 18 some reaction noted July 19 somewhat recovered, but 0800 July 21 died
No. 50 (17 gr)	"	"	0.2 cc	0.24 gr	July 18-19 no reaction July 20 somewhat listless 0620 July 21 died
No. 51 (18 gr)	1135 July 18	"	0.1 cc	0.12 gr	no reaction

Preparation No. 6 10 gr of dried flesh from a barracuda from Japanese waters was broken up fine and left for 14 hours in 100 cc of absolute alcohol at room temperature (30-32° C). The filtrate was evaporated for 2 hours at 100° C. and reduced to 7 cc. The fat was skimmed off before using.

Mouse No. (Weight)	Date and Time of Injection	Where Injected	Amount Injected	Corresponding Amount of Tissue	Results
No. 39 (26 gr)	1050 July 18	abdominal cavity	0.6 cc	0.84 gr	after injection lay without moving July 19 did not move 2100 July 19 died
No. 40 (14 gr)	"	"	0.5 cc	0.70 gr	July 18 did not move until evening July 19 recovered, normal
No. 25 (10 gr)	1040 July 18	subcutaneous	0.3 cc	0.42 gr	appeared listless after injection, but recovered by evening of July 18 and later showed no ill effects
No. 28 (12 gr)	"	"	0.4 cc	0.54 gr	"

Preparation No. 7 10 gr of dried flesh of a lamprey from Japanese waters was placed in 100 cc of absolute alcohol and left for 16 hours at room temperature. 15 cc of water were added to the alcohol and it was heated for 3 hours until the alcohol was driven off and the extract was reduced to 7 cc. The fat was skimmed off before using.

Mouse No. (Weight)	Date and Time of Injection	Where Injected	Amount Injected	Corresponding Amount of Tissue	Results
No. 67 (9.5 gr)	1150 July 18	subcutaneous	0.3 cc	0.42 gr	no reaction noted
No. 68 (10 gr)	"	"	0.35 cc	0.50 gr	1300 July 18 movements listless 1700 July 18 died

Preparation No. 8 10 gr of flesh from the head of a 1-meter specimen of <u>Gymnothorax</u> <u>flavimarginatus</u> Rüppell which had been preserved for 9 months in 10% formalin was left <u>for one week at room temperature</u> in 200 cc of absolute alcohol. Then 15 cc of water was added and the mixture was heated at 100° C until reduced to 8 cc.

Mouse No. (Weight)	Date and Time of Injection	Where Injected	Amount Injected	Corresponding Amount of Tissue	Results
No. 52 (14 gr)	1515 July 26	subcutaneous	0.1 cc	0.12 gr	no effect
No. 51 (14 gr)	"	"	0.3 cc	0.36 gr	"
No. 50 (14 gr)	"	abdominal cavity	0.4 cc	0.48 gr	"
No. 49 (14 gr)	"	subcutaneous	0.2 cc	0.24 gr	"

Preparation No. 9 10 gr of dried flesh of _Gymnothorax flavimarginatus_ Rüppell were broken up in 100 cc of absolute alcohol and left for one week. The filtrate was heated at 100° C and reduced to 15 cc.

Mouse No. (Weight)	Date and Time of Injection	Where Injected	Amount Injected	Corresponding Amount of Tissue	Results
No. 33 (10 gr)	1600 July 26	abdominal cavity	0.4 cc	0.28 gr	no effect
No. 34 (13 gr)	1605 July 26	subcutaneous	0.3 cc	0.21 gr	"
No. 35 (13 gr)	1550 July 26	"	0.2 cc	0.14 gr	"
No. 36 (13 gr)	1540 July 26	"	0.1 cc	0.7 gr	"

Preparation No. 10 160 gr of raw fresh tissue from the central back portion of a specimen of <u>G. flavimarginatus</u> Rüppell 5 feet 7.2 inches in length taken at Jaluit Oct. 29, 1941 was kept in 100 cc of absolute alcohol for one month at room temperature. 10 cc (corresponding to 16 gr of flesh) of this alcohol was taken, 5 cc of water was added, and the mixture heated to 100° C and reduced to 5.5 cc.

Mouse No. (Weight)	Date and Time Injected	Where Injected	Amount Injected	Corresponding Amount of Tissue	Results
No. 58 (9 gr)	1620 July 26	subcutaneous	0.1 cc	0.25 gr	no effect
No. 59 (13 gr)	1625 July 26	"	0.2 cc	0.50 gr	1800 July 26 movements affected 1500 July 27 died
No. 60 (14 gr)	1630 July 26	abdominal cavity	0.4 cc	1.00 gr	1800 July 26 movements affected recovered later

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Table 1

Cat (Weight)	Date and Time of Feeding	Preparation of Feeding	Amount Eaten	Amount of flesh contained in amount eaten	Results
Small tortoise shell (305 gr)	1500 July 12	dried flesh left over from Preparation No. 1, 6.9 gr	6.9 gr	6.9 gr	no effect
small black (530 gr)	"	dried flesh left over from Preparation No. 2 , 7.8 gr	7.8 gr	7.8 gr	"
medium-sized black (600 gr)	"	dried flesh left over from Preparation No. 3, 7.7 gr	6.4 gr	6.4 gr	"

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Table 2

Cat (Weight)	Date and Time of Feeding	Preparation of Feeding	Amount eaten	Amount of flesh contained in Amount eaten	Results
large tortoise-shell (750 gr)	0800 July 12	25 gr of dried salted akajin [Plectropomus truncatus Fowler] boiled with 32 gr of rice, total feeding 107.7 gr	37.3 gr	8.6 gr	no effect
black back (900 gr)	1200 July 12	"	65.6 gr	16.4 gr	"
"	1000 July 12	13 cc of Preparation No. 2 extract boiled with 20 gr of noodles and 50 cc cow's milk to a pasty consistency and refrigerated for 70 hours. Total feeding 76 gr	70.0 gr	48.0 gr	"

amount of fresh tissue corresponding to a lethal dose was 0.75 gr. This cannot properly be compared with the dried tissues because the species used were different, but compared with the lethal dose for the akajin [Plectropomus truncatus], and allowing for shrinkage in drying, it appears that the toxicity is somewhat diminished by this method of preservation.

4. Preservation in formalin

Two experiments were made with the tissues of fish which had been preserved in 10% formalin for 9 months as taxonomic specimens. The results are shown in the tables for Preparations Nos. 5 and 8. There was a wide variation in their toxicity, the lethal dose for one being 1.2 gr and 0.5 gr for the other. It is not known whether one of the specimens was washed in water while being preserved, or whether these results are due to an individual variation in toxicity.

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Preparations Nos. 2 and 8 and Controls Nos. 6 and 7 were made by the same alcohol extraction method and afford an opportunity to note the difference in toxicity as between species. The akajin is in the mildly toxic classification and G. flavimarginatus is strongly toxic. Anticipating this difference, we decreased the amount injected for the latter species, and as a consequence were unable to ascertain the lethal quantity. It is not clear whether the fact that the difference in toxic effect between these two species was not more marked was due to some difference in the method of preparation or to individual variations in the fish. The materials used for controls were dried barracuda purchased at Atami in Shizuoka Prefecture and dried lamprey(probably okimekura) obtained at Odawara in Kanagawa Prefecture. By way of comparison with the lethal quantity of 0.26 gr determined for the akajin, that for the barracuda was 0.7 gr and that for the mekuraunagi was 0.75 gr. It is wondered whether these differences can be ascribed to the preservation of the toxic substances contained in the fresh tissues. The dried fish from the South Seas had been kept for 9 months, while the barracuda had been preserved 2 months and the lamprey for only a few days. Perhaps similar poisons may have developed in the tissues during preservation, but the symptoms observed in these experiments very closely resembled those seen in experiments with fresh material.

A comparison of the methods described above indicates that salting and drying and preservation in formalin are satisfactory. It is thought that canning or bottling would perhaps be best if facilities for complete sterilization were available. It is regrettable that we were unable to experiment with this method. It goes without saying that it would be best to reduce the poison to a chemically pure and stabilized condition. From the author's experience in the field he believes that the next best thing, in areas where chemicals and facilities are lacking, is to preserve the materials by salting and drying or by the use of formalin.

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Section 5 Elimination of the Poison

As shown in the preceding section, the poison is easily extracted in water or alcohol and it is difficult to detect any traces of it remaining in tissues so treated. This method works experimentally, but for practical purposes it would spoil the flavor and make it impossible to eat much of the fish.

The Japanese fishermen of Saipan remove the poison from mildly toxic species only such as the dokuhiraaji [Caranx melampygus] and the sazanamihagi

[*Ctenochaetus strigosus*] in the following manner. They split open the belly and remove the viscera and then soak the fish overnight in icewater. The next day they pound the flesh up fine, wash it in water several times, add wheat flour, and make it into fishcake or fish pudding for sale. It is said that this method has been employed for years without any cases of poisoning resulting. It is not known at present whether this is due to the washing away of the blood or whether the poison is extracted from muscle tissues, but it is reported here as a presumably effective method.

Furthermore, as stated in Section 2, most reported cases of poisoning have resulted from eating fish soup and in most of these cases persons who only drank the broth without eating the pieces of fish contained in it were poisoned. This is evidence that the poison is drawn out into the broth.

Such dishes as sliced raw fish and chilled raw fish [*arai*], especially where the fish has been washed with water, have caused the fewest cases of poisoning.

According to Matsuo the poison is the same as that found in tetraodonts, and is in the blood (not shown by the results of our experiments), consequently, if in mildly poisonous species the blood in the muscle tissues is squeezed out and the tissues are thoroughly washed with water, the fish can be fed to animals without any poisoning resulting. He also recommends the method of making fishcake and chilled raw fish described above. However, it goes without saying that in any case the flesh must be thoroughly ground or chopped up and then washed with water.

For the complete elimination of the poison by these methods it is essential that only those species be used which are recorded in Chapter II as being of a mild degree of toxicity. The wisest course is to abstain completely from eating fish classed as strongly or violently toxic. The popular use of these methods of eliminating the poison is confined to the mildly poisonous species.

Section 1 Popular Theories

As has been reported in the preceding sections of this paper, there have been few accurate scientific studies made of poisonous fishes in the past, but various theories on the subject have been current among natives and Japanese fishermen and residents in the South Seas. They will be examined cursorily in this section.

(1) The theory that fishes which are edible in Japan are poisonous in the South Seas.

This theory was heard wherever the writer traveled. It has already been considered in the paragraph on the species of poisonous fish in Chapter II, but our observations will be repeated here for the reader's benefit. There is not space here to cite all of the species which are given the same names as edible fishes in Japan, but some of them are the kamasu (dokukamasu), suzuki (aona), hiraaji (dokuhiraaji), jaunagi (dokuutsubo), and so forth (in each case the name in parentheses is the standard common name used in this report). These all closely resemble their Japanese namesakes---most of them are of the same genus---and consequently Japanese going to the South Seas and seeing similar fishes there have applied these names to them, but they are entirely distinct species. These poisonous fishes of the South Seas do not occur in Japanese waters (although some of them are found in Okinawa and the Bonins), and the corresponding Japanese edible species do not occur in the South Seas.

For some time the author, seeing only the South Seas species, which so closely resemble those found in Japan, was unable to decide whether they were the same or different species, but by bringing back specimens and comparing them with the Japanese species he was able to see clearly the difference between them. Furthermore, taxonomists have in the past recorded them as distinctly different species.

Note should be taken of this popular belief because it has a very wide circulation and has been subscribed to by many people for a long time.

(2) The theory that the poison is due to the food which the fish eats.

One often hears that fish become poisonous by eating poisonous seaweeds. Matsuo recorded this theory, and it was also heard from fishermen at Saipan. We requested that some of this poisonous seaweed be collected at Tenian in order to find out exactly what it looked like, but the fishermen were afraid to collect it. When asked why, they said that they would have to dive for it and that if it touched the skin, it would cause a burning rash, with subsequent loss of the ability to move the affected part.
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We tried to collect some from a boat with a plankton net, but were unsuccessful. From what the fishermen say, it is assumed that this is some kind of an echinoderm rather than a seaweed.

An examination of the stomach contents of poisonous fishes taken in the vicinity showed neither seaweeds nor fragments of echinoderms but only unidentifiable digested remnants of small fish.

Fishermen also say that the toxicity results from feeding on poisonous crabs. Matsuo also records this. Examination of the stomach contents of poisonous fish collected in the area said to be inhabited by these crabs showed that most of them had been feeding on small siganids (photograph 6 shows the stomach contents of a specimen of dokuhiraaji [Caranx melampygus]) and no crab fragments could be found.

Some persons say that fish which eat coral animals are poisonous, and this theory is also recorded by Matsuo. Among the poisonous fishes there are some, such as the Hepatidae, whose teeth are constructed in such a way that they are thought to eat coral animals, and some have been found to have coral animals in their stomachs, but not all of the fishes cited in this report eat them. If the fish poison originates in the nematocysts of coral polyps, it must be said that the number of species which get the poison directly by eating the polyps is less than the number of those which get it indirectly by feeding on the coral-eating fishes.

Another theory is that fish which feed on small poisonous species (Matsuo cites the iröl, pauij, and ajule, all of which are Marshallese names, the species being unidentifiable) become poisonous, and Matsuo was unable to disprove this theory.

It is clear that there is no definite connection between the feeding habits of any poisonous fish and its toxicity, and the author was unable to discover any certain relationship between the ecology and the toxicity of the 45 species reported in this paper. As far as feeding habits are concerned, some feed on coral (hepatids and callyodontids), some on small fish (carangids), some on demersal shellfish (sparids), and others eat large fish (sphyraenids), so they have nothing in common on that score. Some swim in the surface waters (barracuda), some live in holes in the coral (morays), some swim in the middle layers (hepatids, labrids), and some live on the bottom (lethrinids), so nothing can be deduced from a consideration of their habitats. There seems to be no connection between ecology and toxicity.

(3) Variations in toxicity depending on the habitat

The fishermen at Saipan told the author that there is a definite difference in the toxicity of fish of the same species taken north and south of a line drawn straight out from the government pier at that island. Fish taken even one fathom inside of that line are poisonous, they said. They further reported [Page 132] that the fish at Laulau Bay are not poisonous, while those taken around the poisonous weed beds at Tenian and the places where poisonous crabs occur at Saipan are mostly toxic. In order to test these assertions the author selected three stations, taking the fishermen's theories into consideration, and fished at all three for sazanamihagi [Ctenochaetus strigosus], selecting this species for comparison because it was easy to obtain. Seventeen specimens were collected and tested, and it was impossible to establish any difference between the results from the three stations. (The results are reported in Chapter II in the section on the sazanamihagi.) (It is not possible here to give the exact locations of the stations.)

For the scattered islands of the Marshalls group Matsuo made a detailed record of the variations in toxicity reported by natives from the various islands who visited Jaluit. He listed the native names for fish at sixteen islands and noted the variations in toxicity. The present writer also inquired of the

natives concerning differences in the toxicity of fishes known by the same native names at various islands. Judging from these data there appears to be a tendency for variations in toxicity for the same species at different islands of the same group to be most common in the mildly toxic species and least common in the violently toxic species. The only way to clarify this whole question would be to carry on studies over a long period of time at all of the outlying islands.

A point which should be noted is that fishes to which the same name is given are not necessarily of the same species. An example in Marshallese is dreb, which is a general term used for almost all species of the genus Gymnothorax. The name jowe is a general term for the Serranidae, and there are many other similar examples such as bub (Balistidae), julae (genus Plectropomus), and diebdro (Hepatidae). The same thing is true of Japanese common names, which rarely make fine distinctions between species. For this reason any study which is based only on names is bound to result in confusion.

A comparison of replies to requests for the names of poisonous fishes addressed to various areas gave no useable results, the situation with regard to Japanese common names being even more confused than in the case of the native names. For example, the name akamasu is applied to so many different species that it is useless for exact identification. The fish called aomasu, an altogether distinct species from those just mentioned, is also called susuki at Jaluit and aomachi, ōmachi, or ōmasu at Saipan, giving one the impression of dealing with several different species.

This confusion in nomenclature makes accurate identification impossible, and even though a fish may be edible at one island and a fish with the same name may be shown to be poisonous at another island, no confidence can be placed in this as an evidence of local variation in toxicity.

It should be noted that the results of experiments with animals reported in the various sections of Chapter II show that in many species the toxicity varies as between individual specimens. Although the toxicity of a species may not [Page 133] vary within a limited area, it should be recognized that some variation exists in widely separated regions, as set forth in the following Section 3.

[Page 134] Section 2 On Individual and Seasonal Variations in Toxicity

At the end of the preceding section it was stated that the toxicity of mildly poisonous species varies with the locality. Furthermore, the results of experiments reported in the various sections of Chapter II show that within the same species individuals vary greatly in toxicity. This has given rise to various theories, as reported in the preceding section, but at present the reason for these variations is unknown and it can only be said that they are due to some physiological causes. Quite a few authorities, including Pawlowsky and Poey (op. cit.), have thought that one of these physiological causes is probably related to spawning. The writer regrets that he was unable in the short period of time which this investigation covered to confirm this hypothesis.

It has also been pointed out in Chapter II that in a number of species a variation in toxicity depending on age can be observed. This is true, for example, of Caranx melampygus among others, and Pawlowsky has reported the same

phenomenon for Lethrinus rostratus. It is not known at present whether such a variation exists in all species of poisonous fish or only in certain species, but it should be noted that it occurs in a good many.

It appears that there is no discernible variation in toxicity due to sex.

[Page 135] Section 3 On the Distribution of Poisonous Fishes

A comparison of the Marianas, Carolines, and Marshalls areas of the South Seas shows that poisonous fish occur in the greatest abundance, with the largest number of species, and with the strongest toxicity in the Marshalls. The number of species found in the Marianas is much smaller and few of them are strongly toxic. This investigation did not extend to the Carolines area, however; it appears that although quite a few species occur in the western Carolines, they are almost unknown in the eastern part of the group. Many of the species recorded as poisonous in this paper are distributed throughout this area.

A point which should be noted concerning the distribution of poisonous fishes is that since most of them are taken near the outer reefs by the natives fishing with hook and line or by Japanese using driving-in nets, they are no problem in areas where they are not taken because driving-in nets are not used or where they are taken but not eaten because of local dietary habits. Consequently there may be places where they occur but where they have never been recorded nor reported.

Most of the species treated in Chapter III occur in the Marshalls but only in rare cases are they limited to that area. The majority of them have a wide distribution, many of them occurring in the coastal waters of East Africa, the Red Sea, the Indian Ocean, the East Indies, Hawaii, and North Australia. A more detailed examination shows that the coastal waters of Southeast Asia, that is Malaya, French Indo-China, Thailand, and the China Sea, have few species in common with the Marshalls, and there seem to have been no reports of poisonous fish occurring in those waters. Although the East Indies (Sunda, Borneo, Celebes, etc.) area has a good many species in common with the Marshalls, we have not been able to find any mention of poisonous fish among the numerous papers published there. This may be because they occur rarely there, or because they are not taken by the fishing methods in use there and so do not appear in the market, or because the natives are not, like the Japanese, a fish-eating people. Not having investigated this situation in person, all the writer can say is that judging from the literature published hitherto there are probably no poisonous fishes occurring in the East Indies and the Indian Ocean.

The areas which have the deepest connection with the poisonous fishes of the Marshalls and Marianas cited in this report are Hawaii (including Wake I.) and the so-called Polynesian islands (Fiji, Samoa, Society, New Caledonia, New Hebrides, and so forth). The ichthyfauna of the Marshalls is, as stated by Herre*, [Page 136] most closely related to that of the Hawaiian Islands and the various Polynesian groups.

They have many species in common, the majority of those recorded in this paper being also found in those islands, and it is not difficult to imagine that

*Herre: The Fishes of the Herre Philippine Expedition. Hongkong, 1934.

they must have other poisonous fishes besides the ones which we have cited. It is thought that these islands must have the most numerous and the most violently toxic fishes of any place in the Pacific. It is significant that in the previous literature even Americans, who customarily do not eat much fish, have noted the occurrence of poisonous fish in Samoa. Many of the poisonous species occur in northern Australia, but apparently only tetraodonts are found in the southern part.

In the Atlantic many species of poisonous fish have been reported from the West Indies and surrounding waters. Poey and many others have written of them. They are perhaps more numerous than those of the Pacific.

A map has been inserted in this report showing the distribution of poisonous fishes throughout the world. It shows that these fishes are confined almost entirely to the tropic seas, and they are most numerous around isolated islands far from continental shores. The water in these areas is little affected by drainage from the land, it is poor in plankton, extraordinarily clear, and coral reefs are well developed in it. Poisonous fish seem to be especially abundant around coral atolls.

Because of the parallels between the distribution of coral reefs and that of poisonous fishes, the writer is moved to advance the bold hypothesis that there is a connection, indirect if not direct, between the nematocysts of the coral polyps and the poisonous fishes. In Japan the only poisonous fishes are a few species of tetraodonts, which seem to represent the northern limit of distribution. It is interesting to note that in Okinawa Prefecture, where coral reefs are found, quite a few of the poisonous species cited in this report occur. It is thought that the absence of poisonous fishes from the Indian Ocean, Red Sea, and East Indies, where quite a few of them should be expected to occur, is due to the fact that in many of these areas the coral does not grow well because of the effect of runoff water from the land. The east coast of Asia is a good example, with a great deal of drainage from the land, an ichthyfauna very different from that of the area covered in this investigation, and no poisonous fishes. (end)

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Table 1 dokuutsubo Gymnothorax flavimarginatus Ruppell

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used and Body Weight	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amount eaten	Results	Notes
9777 140 cm.	Jaluit	Oct.27 1400	M. No. 81 right (Approx.10gr)	raw flesh	1510	1 hr 5 min	3.1 gr	Impairment of sensation in hind legs.. Animal survived.	
"	"	"	Cat No.1 (Approx. 1kg)	raw flesh	"	"	33.5 gr	Strong locomotory & sensory impairment. Died (Oct.28 at 1000)	Plate 28, fig. 3
"	"	"	M. No. 81 left (Approx.10gr)	cooked flesh	"	"	3.5 gr	Impairment of sensation in hind legs. Survived.	
"	"	"	Cat. No. 2 (Approx. 1kg)	cooked flesh	"	"	32 gr	Strong locomotory & sensory impairment. Died	Plate 28, fig. 2

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Table 2 dokuutsubo <u>Gymnothorax</u> <u>flavimarginatus</u> Rüppell

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amount eaten & time remainder weighed	Results	Notes
9502 120 cm.	Saipan St. 1	Aug.26 1200	M. No. 120 left	Liver, not mixed with fishmeal	1608	4 hr 8 min	1.0 gr 2015	At 2015 on 8/26 no apparent effect on actions. At 1310 on 8/27, no effect	No test was made for sensory impairment in this experiment.
"	"	"	M. No. 120 right	"	"	"	0.9 gr 2015	"	
9655 120 cm.	"	"	M. No. 101	cooked flesh	1620	4 hr 20 min	2.1 gr 2015	No unusual activity noted. At 1310 on 8/27, no effect.	
"	"	"	"	" "	"	"	2.4 gr 2015	"	
"	"	"	M. No. 102 left	" "	"	"	8.1 gr 2015	"	
"	"	"	M. No. 118 right	raw flesh	1552	3 hr 52 min	2.6 gr 2010	"	
"	"	"	M. No. 119	" "	"	"	"	"	
"	"	"	"	" "	"	"	2.5 gr 2010	"	

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Table 3 dokuutsubo <u>Gymnothorax</u> <u>flavimarginatus</u> Rüppell

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amount eaten & time remainder weighed	Results
9756 62 cm.	Jaluit	Nov. 7	Puppy (2 kg)	head, cooked	0700	?	38 gr	At 1000 on Nov. 8, action of hind legs impaired
"	"	"	Cat No.11 (1.5 kg)	"	"	"	27 gr	No ill effect. Function of hind legs appeared slightly impsired
"	"	"	Cat No. 12 (1.5 kg)	Tail, cooked	"	"	1 gr	23 grams were offered but the animal only held the fish in its mouth without swallowing it.

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Table 4 shiromon dokuutsubo <u>Gymnothorax</u> <u>meleagris</u> Shaw

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results	Notes
9656 48 cm.	Saipan	Sept. 18 1200	M. No. 66	Liver mixed with an equal quantity of fishmeal	1645	4 hr 45 min	1.5 gr Sept. 19 1500	Diarrhea, listless. Recovered next day.	Sensory reactions not tested
"	"	"	M. NO. 67	"	"	"	1.8 gr "	No unusual activity	"
"	"	"	M. No. 68	flesh (from back)	1655	4 hr 55 min	0.8 gr "	Died 9/19 at 1500 Stomach almost empty. No unusual condition in stomach, small intestine congested	Dissection No. 4
"	"	"	M. No. 33	" (")	"	"	1.1 gr "	No unusual activity	Sensory reactions not tested
"	"	"	M. No. 34	" (cooked)	1700	5 hr 0 min	1.1 gr "	"	"
"	"	"	M. No. 35	" (")	"	"	1.4 gr "	"	"

Table 5 namiutsubo <u>Gymnothorax</u> <u>undulatus</u> (Lacépède)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results	Notes
	Saipan, outside reef	Sept. 19 1300	M. No. 109 left	raw flesh	1525	2 hr 25 min	1.5 gr Sept. 20 1350	No unusual activity noted	Sensory reactions not tested
	"	"	" right	"	"	"	"	"	"
	"	"	No. 110 left	"	"	"	"	"	"
	"	"	" right	cooked flesh	1535	2 hr 35 min	1.0 gr "	"	"
	"	"	No. 111 left	"	"	"	"	"	"
	"	"	" right	"	"	"	"	diarrhea, hair fell from head, listless, no movement	"
	"	"	No. 118 left	dried flesh	Sept.28 1110	"	0.6 gr	listless, hair ruffled, no movement	dried since 9/19 at 1500
	"	"	" right	"	"	"	0.4 gr	no unusual activity noted	"

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Table 6 dokukamasu *Sphyraena* *picuda* Bloch & Schneider

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results	Notes
9506 91 cm.	Saipan	Aug. 30 1400	Cat	Flesh (cooked)	2030	6 hr 30 min	40.5gr offered 33.3gr remained 7.2gr eaten	Appeared to stagger. Died at 1040	Flesh taken from belly near pectoral fin
"	"	"	"	Flesh (raw)	2030	"	45.0 gr	Diarrhea but movements not affected	Flesh from tail
"	"	"	M. No. 97 left	6 ≠ 64 liver	2015	6 hr 15 min	1.5 gr	No unusual activity noted	Sensory reactions not tested
"	"	"	" right	"	"	"	"	"	"
"	"	"	M. No. 98 left	"	"	"	2.0 gr	Listless, no movements Recovered	"
"	"	"	" right	"	"	"	0.9 gr	no unusual activity noted	"

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Table 7 dokukamasu <u>Sphyraena</u> <u>picuda</u> Bloch & Schneider

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results	Notes
9506 91 cm.	Saipan	Aug. 30 1400	M. No. 99 left	flesh	2025	6 hr 25 min	0.8 gr 1030	no unusual activities noted at 1030	flesh from belly near pectoral fin, sensory reactions not tested
"	"	"	" right	"	"	"	2.4 gr "	"	sensory reactions not tested
"	"	"	No. 100 left	flesh (cooked)	2030	6 hr 30 min	2.2 gr "	"	"
"	"	"	" right	"	"	"	3.4 gr "	listless, no movements, recovered	-
"	"	"	M. No. 117 left	dried flesh	Sept.28 1110	"	0.3 gr	no effect	began drying 9/19 at 1100
"	"	"	" right	"	"	"	0.4 gr	"	

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Table 8 dokukamasu Sphyraena picuda Bloch & Schneider

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results	Notes
9615 length not recorded	Saipan, outside reef	Sept. 18 2300	M. NO. 99 left	flesh (anterior to pectoral fin)	Sept. 19 1120	12 hr 20 min	1.4 gr Sept. 20 1405	no unusual activity noted	sensory reactions not tested
"	north of Matansha	"	" right	"	"	"	"	"	"
"	"	"	No. 100 left	(cooked flesh)	1125	12 hr 25 min	1225	diarrhea, no unusual activity noted	"
"	"	"	" right	"	"	"	"	no unusual activity noted	"

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Table 9 ōmekamasu <u>Sphyraena</u> <u>forsteri</u> Cuvier & Valenciennes

erial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
9722 58 cm.	Jaluit	Oct. 31 0300	M. No. 83 left	cooked flesh	0650	3 hr 50 min	3 gr Nov. 11 [sic] 0730	no sensory or locomotory impairment after 1 hour
"	"	"	" right	"	"	"	1.2 gr "	weakened
"	"	"	Cat No. 1	"	"	"	32.0 gr "	very slight sensory and locomotory impairment
"	"	"	Cat No. 2	raw flesh	"	"	28.2 gr "	no ill effects
"	"	"	M. No. 81 left	liver	0630	3 hr 30 min	2.0 gr Nov. 1 0730	slightly listless on Nov. 1 but no sensory or locomotory impairment
"	"	"	" right	"	"	"	" "	"
"	"	"	No. 82 left	raw flesh	"	"	2.2 gr "	no ill effects
"	"	"	" right	"	"	"	" "	action of hind legs impaired

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Table 10 ōmekamasu *Sphyraena forsteri* Cuvier & Valenciennes

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
9786 56 cm.	Jaluit	Nov. 10 early morning	Cat No. 8	cooked flesh, head	0700	--	44.5 gr	at 1103 action of hind legs slightly impaired
"	"	"	Cat No. 9	raw flesh, tail	"	"	37.2 gr	"
"	"	"	M. No. 90 right	raw flesh, head	"	"	2.5 gr	weakened
"	"	"	No. 91 left	raw flesh, tail	"	"	2.7 gr	"
"	"	"	" right	1:1 liver	"	"	2.0 gr	no effect

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Table 11 dokuhirsaji *Caranx melampygus* Cuvier & Valenciennes

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
9631 71 cm.	Saipan St. 1	Aug. 25	Cat No. 3 (1 kg)	raw flesh	1500	6 hr 0 min	44.0 gr	no effect at 0800 Aug. 26
"	"	"	Cat No. 4 (1 kg)	cooked flesh	"	"	52.5 gr	vomiting and diarrhea, expelled entire stomach contents

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Table 12 dokuhiraaji Caranx melampygus Cavier & Valenciennes

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
9631 71 cm.	Saipan St. I	Aug. 25 0900	M. No. 85	39.3 gr of flesh ⨍ 8 gr fishmeal divided into 8 equal portions	1930	10 hr 30 min	2.6 gr 0800	no effect at 0800 on Aug. 26
"	"	"	"	"	"	"	08gr "	"
"	"	"	No. 86	"	"	"	3.2 gr "	"
"	"	"	"	"	"	"	1.8 gr "	"
"	"	"	No. 87	"	"	"	1.2 gr "	"
"	"	"	"	"	"	"	2.1 gr "	"
"	"	"	No. 88	"	"	"	2.8 gr "	"
"	"	"	"	"	"	"	1.0 gr "	"

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Table 13 dokuhiraaji *Caranx melampygus* Cavier & Valenciennes

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
9631 71 cm.	Saipan St. I	Aug. 25 0900	M. No. 85	28 gr of flesh / 10 gr of fishmeal in 10 equal portions	1055	1 hr 55 min	0.7 gr 1545	no effect at 1545
"	"	"	"	"	"	"	0.3 gr "	"
"	"	"	No. 86	"	"	"	0.9 gr "	"
"	"	"	"	"	"	"	1.3 gr "	"
"	"	"	No. 87	"	"	"	1.6 gr "	"
"	"	"	"	"	"	"	— "	"
"	"	"	No. 88	"	"	"	1.2 gr "	"
"	"	"	"	"	"	"	1.1 gr "	"
"	"	"	No. 105	"	"	"	1.6 gr "	"
"	"	"	"	"	"	"	1.3 gr "	"

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Table 14 dokuhiraaji <u>Caranx</u> <u>melampygus</u> Cuvier & Valenciennes

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
9631 71 cm.	Saipan St. I	Aug. 25 0900	M. No. 6	38.1 gr of ovary ≁ 10 gr of fishmeal in 10 equal portions	1044	1 hr 44 min	1.8 gr 1530	No effect at 1530
"	"	"	"	"	"	"	2.0 gr "	"
"	"	"	No. 5	"	"	"	1.9 gr "	"
"	"	"	"	"	"	"	—— "	"
"	"	"	No. 106	"	"	"	0.3 gr "	"
"	"	"	"	"	"	"	0.3 gr "	"
"	"	"	No. 107	"	"	"	—— "	"
"	"	"	"	"	"	"	1.1 gr "	"
"	"	"	No. 108	"	"	"	1.1 gr "	"
"	"	"	"	"	"	"	1.9 gr "	"

Table 15 dokuhiraaji <u>Caranx</u> <u>melampygus</u> Cuvier & Valenciennes

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results	Notes
9631 71 cm.	Saipan St. I	Aug. 25 0900	M. No. 82	19.5 gr of liver + 10 gr of fishmeal in 10 equal portions	1030	1 hr 30 min	—— 1520	No effect at 1520	
"	"	"	"	"	"	"	1.0 gr "	"	
"	"	"	No. 83	"	"	"	0.2 gr "	"	
"	"	"	"	"	"	"	—— "	"	
"	"	"	No. 84	"	"	"	0.3 gr "	"	
"	"	"	"	"	"	"	0.5 gr "	"	
"	"	"	No. 8	"	"	"	" "	"	
"	"	"	"	"	"	"	—— "	testicles prolapsed (lesion)	probably from a bi[te] received earlier
"	"	"	No. 7	"	"	"	0.2 gr "	no effect	
"	"	"	"	"	"	"	" "	"	

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Table 16 dokuhiraaji *Caranx melampygus* Cuvier & Valenciennes

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
9631 71 cm.	Saipan St. I	Aug. 25 0900	M. No. 101	blood and fish meal $\frac{108 + 10}{10}$	1015	1 hr 15 min	0.8 gr 1520	no effect at 1520, however, sensory reactions not tested
"	"	"	"	"	"	"	1.2 gr "	"
"	"	"	No. 102	"	"	"	1.0 gr "	"
"	"	"	"	"	"	"	0.6 gr "	"
"	"	"	No. 103	"	"	"	0.8 gr "	"
"	"	"	"	"	"	"	0.9 gr "	"
"	"	"	No. 104	"	"	"	0.6 gr "	"
"	"	"	"	"	"	"	—— "	"
"	"	"	No. 81	"	"	"	0.8 gr "	"
"	"	"	"	"	"	"	1.1 gr "	"

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Table 17 dokuhiraaji Caranx melampygus Cuvier & Valenciennes

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
none 90 cm.	Saipan	Aug. 31 1530	Cat 1 (1 kg)	raw flesh	1720	1 hr 50 min	48.2 gr	at 0930 on Sept. 1 vomited, could not get up. Recovered later
"	"	"	Cat 2 (2.5 kg)	cooked flesh	"	"	76.7 gr	vomited, diarrhea (since before feeding?) Ran away.
"	"	"	Cat 3 (1 kg)	raw liver	"	"	10.1 gr	Died. (no record of progress of poisoning

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Table 18 dokuhiraaji Caranx melampygus Cuvier & Valenciennes

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
none length 90 cm	Saipan	August 31 1530	M. No. 88	cooked flesh	1720	1 hr 50 min	0.4 gr Sept. 1 0930	slight diarrhea, listless at 0930 Sept. 1
"	"	"	"	"	"	"	0.3 gr "	no effect
"	"	"	M. No. 93	blood	1615	45 min	0.8 gr Sept. 1 0930	movements listless, diarrhea at 0930 Sept. 1
"	"	"	"	"	"	"	1.1 gr "	movements listless
"	"	"	M. No. 94 left	"	"	"	1.2 gr "	movements listless, hair fell from head
"	"	"	" right	1 gr + 1 gr liver	1140	1 hr 10 min	0.9 gr Sept. 1 0930	"
"	"	"	M. No. 95	"	"	"	0.9 gr "	"
"	"	"	"	"	"	"	0.8 gr "	diarrhea, listless
"	"	"	M. No. 96	raw flesh	1645	1 hr 15 min	1.4 gr Sept. 1 0930	listless
"	"	"	"	"	"	"	2.0 gr "	"

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Table 19 dokuhiraaji Caranx melampygus Cuvier & Valenciennes

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results	Notes
none length 90 cm	Saipan	Sept. 1 0900	M. No. 97	Flesh (head)	1715	5 hr 15 min	1.4 gr	violent disrrhea at 0825 Sept. 2	fed flesh from inside operculum
"	"	"	"	"	"	"	1.9 gr	diarrhea, slightly listless	
"	"	"	M. No. 110	flesh (cooked)	1735	8 hr 35 min [Sic]	1.9 gr	"	flesh from dorsal side of head (cooked)
"	"	"	"	"	"	"	1.0 gr	"	

This fish was taken east of ______________ and was left exposed to the air until we got it.

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Table 20 niramihiraaji *Caranx lessonii* Cuvier & Valenciennes

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
9785 51 cm.	Jaluit	Nov. 10 early morning	Cat No. 14 (0.8 kg)	head, cooked	0600	---	33.4 gr	functioning of hind quarters affected (slightly)
"	"	"	Cat No. 13 (0.5 kg)	tail, raw	"	"	34.9 gr	" (strongly)
"	"	"	M. No. 89 left	tail, cooked	"	"	1.9 gr	somewhat weakened
"	"	"	" right	head, raw	"	"	3.3 gr	weakened
"	"	"	M. No 90 left	liver 1 / 1	"	"	2 gr	"

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Table 21 niramihiraaji *Caranx lessonii* Cuvier & Valenciennes

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
9710 49 cm.	Jaluit	Nov. 4 0600	Cat No. 1 (0.8 kg)	tail, raw	0700	1 hr 0 min	24 gr	hind legs strongly affected, could hardly walk
"	"	"	Cat No. 2 (0.8 kg)	head, cooked	"	"	17.5 gr	hind legs affected, locomotion resembled crawling
"	"	"	Cat No. 3 (0.7 kg)	head, raw	"	"	30 gr	hind legs somewhat affected, but was able to walk some distance

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Table 22 niramihiraaji *Caranx lesonii* Cuvier & Valenciennes

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
9766 23 cm.	Jaluit	Nov. 8	Cat 9 (0.3 kg)	side, cooked	0600	—	37 gr	absolutely no effe

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Table 23 akadokutarumi _Lutjanus vaigiensis_ (Quoy & Gaimard)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
9630 53.6 cm.	Saipan St. I	Aug. 26 0910	M. No. 106	flesh	1938	10 hr 28 min	2.4 gr Aug. 27 0840	no effect still no effect at 1330 Aug. 27
"	"	"	"	"	"	"	1.8 gr "	"
"	"	"	M. No. 107 left	"	"	"	1.8 gr "	"

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Table 24 akadokutarumi _Lutjanus vaigiensis_ (Quoy & Gaimard)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
" [sic]	Saipan	Aug. 31	Cat No. 4 (0.8 kg)	flesh, raw	1730	" [sic]	41.7 gr	vomiting, legs gave way, diarrhea, died at 1530 on Sept. 1 (viscera photographed)
"	"	"	Cat No. 5 (0.8 kg)	Flesh, cooked	"	"	40.6 gr	vomiting, diarrhea, died at 1400 on Sept. 1
"	"	"	Cat No. 6 (0.9 kg)	raw liver	"	"	15.2 gr	vomiting, diarrhea, could not get up, died at 1400 on Sept. 1

Table 25 akadokutarumi <u>Lutjanus vaigiensis</u> (Quoy & Gaimard)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
" [sic]	Saipan	Aug. 31 1600	M. No. 86	raw flesh	1700	1 hr 0 min	1.6 gr Sept. 1 0900	no effect at 0930 Sept. 1
"	"	"	"	"	"	"	1.3 gr "	"
"	"	"	M. No. 87	1.5 ≠ 1.5 = 3 gr liver	"	"	1.6 gr "	"
"	"	"	"	"	"	"	" "	"
"	"	"	M. No. 81	cooked flesh	1720	1 hr 20 min	0.4 gr "	"
"	"	"	"	"	"	"	3.0 gr "	slight diarrhea, listless
"	"	"	M. No. 85	1.5 ≠ 1.5 = 3 gr blood	1700	1 hr 0 min	1.5 gr "	no effect
"	"	"	"	"	"	"	1.5 gr "	"

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Table 26 skadokutarumi _Lutjanus vaigiensis_ (Quoy & Gaimard)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
" [sic]	Saipan, outside reef north of Matansha	Sept. 18 2300	M. No. 107	raw flesh (side of tail)	Sept.19 1050	11 hr 50 min	1.8 gr Sept. 20 1350	no effect
"	"	"	"	" "	"	"	2.0 gr "	"
"	"	"	M. No. 108	" (head)	"	"	" "	"
"	"	"	"	" "	"	"	" "	"
"	"	"	M. No. 115	cooked flesh (side of head)	Sept.19 1105	12 hr 05 min	" "	"
"	"	"	"	" "	"	"	" "	"
"	"	"	M. No. 116	" (tail)	1110	12 hr 10 min	1.5 gr "	"
"	"	"	Cat (1.3 kg)	" (head)	1130	12 hr 30 min	34.7 gr "	no effect at 1500 Sept. 19

Table 27 akadokutarumi _Lutjanus vaigiensis_ (Quoy & Gaimard)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
9606 ? 70 cm ?	Kita-jima	Sept. 19	M. No. 109	raw flesh (head)	Sept. 20 1450		Sept. 21 1545	no effect
"	"	"	"	"	"		"	"
"	"	"	M. No. 110	" (tail)	"		"	"
"	"	"	"	"	"		"	"
"	"	"	No. 101	cooked flesh (head)	Sept. 20 1530		"	"
"	"	"	"	"	"		"	slight diarrhea
"	"	"	No. 102	" (tail)	1535		"	"
"	"	"	"	"	"		"	died, stomach contents red slimy fluid, no ulcers, no other effect No. 6

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Table 28 akadokutarumi <u>Lutjanus</u> <u>vaigiensis</u> (Quoy & Gaimard)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results	Notes
9606 70 cm	Saipan	Sept. 19	M. No. 119	dried flesh	Sept. 28 1111		0.3 gr	No effect	IX. dried 1100 on Sept. 19
"	"	"	"	"	"		0.3 gr	"	"
"	"	"	M. No. 81	"	Sept. 28 1300 [?]		0.4 gr	"	IX. dried 1500 on Sept. 20
"	"	"	"	"	"		0.2 gr	"	"

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Table 29 akadokutarumi <u>Lutjanus</u> <u>vaigiensis</u> (Quoy & Gaimard)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
9630 53.6 cm	Saipan-Tenian	Sept. 26	M. No. 89	Raw flesh (head & nape)	Sept. 27 1110	Time of capture [sic]	1.9 gr Sept. 28 1000	No effect
"	"	"	"	"	"	"	1.9 gr "	"
"	"	"	M. No. 90 left	" (blood-filled portion of nape)	"	"	1.8 gr "	"
"	"	"	" right	"	1120	"	0.9 gr "	"
"	"	"	No. 91	" (Pectoral area)	"	"	0.6 gr "	"
"	"	"	"	"	"	"	3.0 gr "	"
"	"	"	No. 92	" (tail)	1133	"	1.3 gr "	"
"	"	"	"	"	"	"	1.2 gr "	"
"	"	"	No. 93	cooked flesh (head)	1200	"	0.9 gr "	"
"	"	"	"	"	"	"	2.0 gr "	"

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Table 30 akadokutarumi <u>Lutjanus</u> <u>vaigiensis</u> (Quoy & Gaimard)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
9630 56.6 cm	Saipan-Tenian	Sept. 26	M. No. 94	cooked flesh (pectoral area)	Sept.27 1205		1.3 gr Sept. 28 1000	no effect
"	"	"	"	"	"	"	1.8 gr "	"
"	"	"	No. 94 [Sic]	" (tail)	"	"	1.2 gr "	"
"	"	"	"	"	"	"	2.3 gr "	"

Table 31 akadokutarumi *Lutjanus vaigiensis* (Quoy & Gaimard)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results	
9501 79.0 cm	Saipan St. I	Aug. 26 0910	M. No. 108 right	$\frac{18.3 + 18.3}{3}$ blood	1103	1 hr.57 min.	0.7 gr 1507	no effect at 1607	no effect at 1330 Aug. 27
"	"	"	No. 113	"	"	"	1.1 gr "	"	"
"	"	"	"	"	"	"	0.7 gr "	"	"
"	"	"	No.114	$\frac{11.4 + 11.4}{10}$ liver	1110	2hr.0 min.	1.1 gr 1510	no effect at 1510	no effect at 1300 Aug. 27
"	"	"	"	"	"	"	1.0 gr "	"	"
"	"	"	No. 115 left	"	"	"	1.1 gr "	"	"

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Table 32 akadokutarumi Lutjanus vaigiensis (Quoy & Gaimard)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results	
9501 79.0 cm	Saipan St. 1	Aug. 26 0910	M. No. 117	Flesh (cooked)	1125	2 hr. 05 min.	2.7 gr 1310	no effect at 1320	no effect at 1330 Aug. 27
"			"	"	"	"	2.0 gr "	"	"
"			M. No. 118 left	"	"	"	2.7 gr "	"	"
"			No. 115 Right	flesh	1118	2 hr. 08 min.	0.5 gr 1315	no effect at 1315	no effect at 1300 Aug. 27
"			No. 116	"	"	"	0.5 gr "	"	"
"			"	"	"	"	1.8 gr "	"	"

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Table 33 futatsuboshidokugyo Lutjanus bohar (Forskål)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9693 24.7 cm	Jaluit	Oct. 27	M. No. 82 left	raw flesh	1510	" [sic]	2.1 gr	no Effect
"	"	"	Cat No. 3 (1.1 kg)	"	"	"	17.2 gr	ran away
"	"	"	M. No. 3 right	cooked flesh	"	"	1.6 gr	no effect
"	"	"	Cat No. 4 (1.2 kg)	"	"	"	17.2 gr	in good spirits, no effect
"	"	"	M. No. 82 right	1 + 1 liver	"	"	1.8 gr	no effect

sble 34 fuedokutarumi <u>Lutjanus</u> (<u>Loxolutjanus</u>) sp.

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9645 24.8 cm	Saipan	Sept. 17 0900	M. No. 3 right	raw flesh (dorsal side of head)	1515	15 hr 15 min Sic	1.5 gr Sept. 18 1430	no effect
"	"	"	No. 4 left	"	"	"	1.5 gr "	"
"	"	"	" right	" (ventral side of tail)	"	"	0.8 gr "	"
"	"	"	No. 93 left	"	"	"	0.8 gr "	listless, no movement
"	"	"	" right	" (dorsal side of tail)	"	"	1.5 gr "	"
"	"	"	No. 94 left	"	"	"	1.5 gr "	slightly listless
"	"	"	" right	liver	1520	6 hr 20 min	0.5 gr "	no effect
"	"	"	No. 95 left	"	"	"	1.0 gr "	"
"	"	"	" right	cooked flesh (ventral side of tail)	1530	6 hr 30 min	1.5 gr "	"
"	"	"	No. 96	"	"	"	1.5 gr	"

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Table 35 fusdokutarumi Lutjanus (Loxolutjanus) sp.

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9646 24.8 cm	Saipan	Sept. 17 0900	M. No. 43	Cooked flesh (dorsal side of head)	1542	6 hr 45 min	0.9 gr Sept. 18 1520	diarrhea, listless
"	"	"	No. 44	"	"	"	1.0 gr "	"
"	"	"	No. 21	" (dorsal side of tail)	1545	6 hr 45 min	0.9 gr "	no effect
"	"	"	No. 22	"	"	"	0.9 gr "	"

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Table 36 fuedokutarumi Lutjanus (Loxolutjanus) sp.

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9685 330 cm	Jaluit	Aug. 27	M. No. 84 left	raw tail	1545		1.6 gr	Aug. 28 at 0800 sensory impairment in hind legs, locomotion not affected
"	"	"	Cat No. 5 (1.2 kg)	"	"		39 gr	Could not stand, light degree of sensory and locomotory impairment, recovered in 2 days
"	"	"	M. No. 83 left	1:2 liver	"		1.3 gr	no effect
"	"	"	Cat No. 6	cooked head	"		41 gr	ran away
"	"	"	M. NO. 117 left	"	"		2.2 gr	slight sensory impairment

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Table 37 misekurohoshitarumi *Lutjanus fulviflamma* (Forskål)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9657 30 cm	Outside reef north of Matasha [Saipan]	Sept. 18 2300	M. No. 97	raw flesh (head)	Sept. 19 1110	12 hr 10 min	1 gr Sept. 19 1110	no effect, sensory reactions not tested
"	"	"	"	"	"	"	1 gr "	"
"	"	"	No. 98	" (tail)	1115	12 hr 15 min	1 gr "	"
"	"	"	"	"	"	"	1 gr "	"
"	"	"	No. 117	cooked flesh (tail)	1125	12 hr 25 min	1 gr "	"
"	"	"	"	"	"	"	0.7 gr "	"
"	"	"	No. 118	" (head)	"	"	1.8 gr "	"

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Table 38 nisekurohoshitarumi Lutjanus fulviflamma (Forskål)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9598	Jaluit	Nov. 5	Cat No. 3	cooked side fillet		6 days 11 hrs refrigerated	24.3 gr	ran away

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Table 39 yoitarumi Lutjanus flavipes (Valenciennes)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9679 22 cm	Jaluit	Nov. 5	Cat No. 2 (o.8 kg)	cooked side fillet	1400	6 da. 11 hrs refrigerated	7.4 gr	no effect

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Table 40 yūdachitarumi Lutjanus semicinctus (Quoy & Gaimard)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9757 27.0 cm	Jaluit	Nov. 6	Cat No. 9	tail, raw	Nov. 6 0200 [?]	-----	23.5 gr	no effect
"	"	"	Cat No. 10	head, cooked	"	"	29 gr	"

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Table 41 aona *Aprion virescens* Valenciennes

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9503 61.0 cm	Saipan	Sept.1 0900	M. No. 102	flesh (cooked)	1725	8 hr 50 min	2 gr	at 0830 Sept.2 slight diarrhea, listless, movements not lively (flesh from dorsal side of head
"	"	"	"	"	"	"	1.7 gr	diarrhea, listless, hair fell from head, movements not lively
"	"	"	M. No. 99	flesh(raw)	1725 [Sic]	8 hr 25 min	0.3 gr	at 0830 Sept.2 slight diarrhea, slightly listless, 2 days later somewhat better but lost much hair from head, movements sluggish (flesh from surface of opercle)
"	"	"	"	"	"	"	2.5 gr	diarrhea, slightly listless, movements sluggish

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Table 42 aona <u>Aprion virescens</u> Valenciennes

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weigh-ing remainder	Results
9503 61.0 cm	Saipan	Aug. 30 1400	M. No. 105	$\frac{3.8 + 3.8}{4}$ liver	2000	6 hr 0 min	1.5 gr	no effect
"	"	"	"	"	"	"	1.6 gr	"
"	"	"	No. 106	"	"	"	1.3 gr	"
"	"	"	"	"	"	"	1.3 gr	"
"	"	"	No. 107	flesh	"	"	-------	"
"	"	"	"	"	"	"	-------	"
"	"	"	No. 108	flesh (cooked)	2015	6 hr 20 min	2.3 gr	1030 slightly list-less, no activity
"	"	"	"	"	"	"	1.9 gr	no effect
"	"	"	Cat	"	2015	6 hr 15 min	40.4 gr 1030	regurgitated whole feeding (flesh from belly near pectoral)
"	"	"	"	flesh (raw)	"	"	" "	no effect (flesh was the cut next to that used in the above experiment)

Table 43 kitsunekuchibi *Lethrinus miniatus* (Schneider)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9800 42.0 cm	Saipan near Gunkan I.	Sept.11 0800	Cat No.1	flesh from back (raw)	0830	30 min	34.8 gr	no particuler effect
"	"	"	Cat No. 2	" (cooked)	"	"	"	"
"	"	"	M. No. 89	1 ≠ 1 liver	0850	50 min	0.2 gr 1500	no effect at 1500
"	"	"	"	"	"	"	" "	"
"	"	"	M. No. 90	1 ≠ 1 blood	0900	1 hr	0.8 gr "	"
"	"	"	"	"	"	"	0.6 gr "	"
"	"	"	M. No. 91	raw flesh	0910	1 hr 10 min	0.3 gr	"
"	"	"	"	"	"	"	1.4 gr "	?
"	"	"	M. No. 92	cooked flesh	0940	1 hr 40 min	1.2 gr	listless
"	"	"	"	"	"	"	0.7 gr "	"

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Table 44 variety of kitsunekuchibi <u>Lethrinus</u> <u>miniatus</u> (Schneider)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9755 41.0 cm	Jaluit	Nov. 6	Cat No. 7	head, cooked	Nov. 6 1400 [?]	" [Sic]	23.5 gr	walking impaired, senses dulled
"	"	"	Cat No. 8	tail, raw	"	"	25.5 gr	walking ability impaired

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Table 45 usugumokuchibi <u>Lethrinus</u> sp.

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9725 41 cm	Jaluit	Nov. 4	Cat No. 2	head, raw	---	-----	0	did not eat, no effect
"	"	"	Cat No. 2	part next to head, cooked			20 gr	no effect
"	"	"	Cat No. 3	tail, raw			0	did not eat, no effect

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Table 46 Lethrinus sp. (variety not known)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9727 52.4 cm	Jaluit	Oct. 31	M. No. 84 left	1 ≠ 1 liver	0700	" [Sic]	2.0 gr Nov. 1 0730	no effect after 1 hr
"	"	"	" Right	raw	"	"	1.9 gr "	slightly weakened
"	"	"	M. No. 109 left	cooked	"	"	2.0 gr "	weakened, locomotion impaired
"	"	"	Cat No. 3	raw	"	"	35.0 gr "	locomotory and sensory impairment
"	"	"	Cat No. 4	cooked	"	"	35.0 gr "	locomotory and sensory impairment, weak in the legs

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Table 47 Muneakakuchibi <u>Lethrinus</u> <u>variegatus</u> Valenciennes

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results	Notes
9723 33.4 cm	Jaluit	Oct. 31 0700	M. No. 109 right	1 ≠ 1 liver	0750	50 min	1.0 gr Nov. 1 0740	no effect	
"	"	"	No. 110 left	head, raw	"	"	1.8 gr "	no feeling in hind legs	
"	"	"	right	head, cooked	"	"	2.0 gr "	"	
"	"	""	Cat No. 5	head, raw	"	"	38.0 gr "	no locomotory or sensory impairment	
"	"	"	Cat No. 6	tail, cooked	"	"	34.0 gr "	dying, almost no feeling, could not get up, pulse still beating at 0600 on Nov. 1	died in the evening

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Table 48 hoakakuchibi <u>Lethrinus</u> <u>sp</u>.

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since captured)	Amt. eaten & Time of Weighing remainder	Results
9745 37.0 cm	Jaluit	Nov. 5	Cat No. 3	head, cooked	0700	-------	32.2 gr	no effect
"	"	"	Cat No. 4	tail, raw	"	"	40.5 gr	"

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Table 49 amakuchibi <u>Lethrinus</u> <u>kallopterus</u> Bleeker

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9791 30.0 cm	Jaluit	Nov. 12	Cat No. 9	flesh from pectoral area (cooked)	0730	------	20 gr	no effect
"	"	"	Cat No. 10	flesh from tail (raw)	"	"	20 gr	"

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Table 50 dokudai Monotaxis grandoculis (Forskål)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9697 23.8 cm	Jaluit	Oct. 28 1200	Cat. No. 3	head, cooked	1603	1 hr 03 min	16 gr	moribund, no sensation unable to move except to open eyes; died
"	"	"	Cat No. 4	tail, cooked	"	"	14.0 gr	moribund, no sensation, unable to move; died at 1000 [?]
"	"	"	M. No. 117 left	head, raw	"	"	1.0 gr	lost sensation in hind legs, movements sluggish, died at 1000 [?]
"	"	"	" right	tail, raw	"	"	0.8 gr	"
"	"	"	M. No. 118 left	head, cooked	"	"	0.4 gr	sensory impairment in all four legs, mild locomotory impairment
"	"	"	" right	tail, cooked	"	"	0.3 gr	strong locomotory impairment, sensory impairment in all four legs
"	"	"	No. 110 right	1 ≠ 1 liver	"	"	0.8 gr	mild sensory impairment, locomotion unimpaired

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Table 51 nokogiridai Gnathodentex aurolineatus (Lacépède)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9773 21.1 cm	Jaluit	Nov. 8	Cat No. 6	side fillet, cooked	0600		15 gr	hind legs affected, could not straighten them, recovered later

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Table 52 mejidai Gymnocranius microdon (Bleeker)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9688 20.2 cm	Jaluit	Oct. 27 1200	M. No. 118 left	liver	1610	16 hr 10 min	1.0 gr	no effect
"	"	"	No. 119 left	tail, raw	"	"	0.5 gr	"
"	"	"	" right	head, cooked	"	"	1.1 gr	"

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Table 53 urokosagi Gerres baconensis (Evermann & Seale)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9769	Jaluit	Nov. 8	Cat No. 10	side fillet, cooked	0900	------	24 gr	no effect

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Table 54 kisujihimeji Mulloidichthys erythrinus (Klunzinger)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9689	Jaluit	Oct. 28 1200	M. No. 81 left	liver mixed with equal quantity of fishmeal	1600	4 hr	0.7 gr	no effect at 0700 Oct. 29
"	"	"	" right	belly, raw	"	"	1.4 gr	"
"	"	"	No. 82 left	"	"	"	0.8 gr	"
"	"	"	No. 83 right	tail, cooked	"	"	2.9 gr	"
"	"	"	Cat No. [?]	side fillet, raw	"	"	13.5 gr	"

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Table 55 kisujihimeji *Mulloidichthys erythrinus* (Klunzinger)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9699	Jaluit	Oct. 28 1200	Cat No. 2	side fillet, cooked	1600	4 hr	1.2 gr	no effect at 0700 Oct. 29
"	"	"	M. No. 82 right	tail, cooked	"	"	1.8 gr	"
"	"	"	No. 83 left	"	"	"	2.0 gr	"
"	"	"	No. 84 left	belly, raw	"	"	1.8 gr	"
"	"	"	No. 84 right	"	"	"	1.4 gr	"

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Table 56 yashabera *Cheilinus fasciatus* (Bloch)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9748 23.2 cm	Jaluit	Nov. 5	Cat No. 1	side fillet, cooked	Nov. 5 1400		15.8 gr	almost no effect, hind legs perhaps slightly affected

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Table 57 hanabibera <u>Cheilinus</u> sp.

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9734	Jaluit	Oct. 31	M. No. 111 right	1 ≠ 1 liver	0800		x ½ 0.6 gr 0740 Nov. 1	no effect; said to be poisonous
"	"	"	" right [Sic]	tail, raw	"		1.7 gr "	slight loss of sensation in hind legs
"	"	"	M. No. 112 left	head, cooked	"		2.0 gr	locomotory impairment of hind legs
"	"	"	Cat No. 7 weight approx. 1 kgr	tail, raw	"		"	did not eat [sic]
"	"	"	Cat No. 8 weight approx. 500 gr	tail, cooked	"		19.5 gr	ate the night of Oct. 31, no effect at 0600 Nov. 1

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Table 58 kumadoribera <u>Coris</u> <u>gaimardi</u> (Quoy & Gaimard)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weigh-ing remainder	Results
9687 27.0 cm	Jaluit	Oct. 27	M. NO. 84 right	1 ≠ 1 liver	1600	-----	1.3 gr	sensory and locomotory impairment in hind legs
"	"	"	M. No. 117 right	tail, raw	"	"	26 gr [sic]	no effect
"	"	"	Cat No. 6	"	"	"	16.7 gr	"
"	"	"	Cat No. 4	head, cooked	"	"	23 gr	could not stand up, sensory impairment in all four legs
"	"	"	M. No. 118 right	"	"	"	2.0 gr	sensory impairment in hind legs

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Table 59 gichibera Epibulus insidiator (Pallas)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9749 22.6 cm	Jaluit	Nov. 5	Cat No. 3	head, cooked	1400	-----	16.9 gr	some effect on locomotory function of hind legs noted
"	"	"	M. No. 91 left	tail, raw	"	"	2.0 gr	weakened, movements uncoordinated, no sensation in hind legs

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Table 60 aobabudai Callyodon microrhinos (Bleeker)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9763 32.7 cm	Jaluit	Nov. 7	Cat No. 17	head, cooked	Nov. 7 0700		6.5 gr	no observable effect

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Table 61 yoroibudai <u>Callyodon</u> <u>pulchellus</u> (Rüppell)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9751 41.4 cm	Jaluit	July 5	Cat No. 1	cooked side fillet	1400	6 days 11 hrs refrigerated	28.4 gr	no effect at 0600 on the 7th

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Table 62 ohagurohata <u>Cephalopholis</u> <u>argus</u> Schneider

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9508 33.6 cm	Saipan St. I	Aug. 25 1000	M. No. 106	flesh	1035	35 min	1.6 gr 1457	no effect at 1457
"	"	"	"	"	"	"	1.3 gr "	"
"	"	"	M. No. 107	"	"	"	0.9 gr "	"
"	"	"	"	flesh (cooked)	1036	36 min	1.3 gr "	1500
"	"	"	M. No. 108 left	"	"	"	2.3 gr "	"

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Table 63 ohagurohata _Cephalopholis_ _argus_ Schneider

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results	
9508 33.6 cm	Saipan	Aug. 26 0900	M. No. 102 right	flesh	Aug. 26 1922	10 hr 22 min	2.0 gr 0830	no effect	no effect at 1330 Aug. 27
"	"	"	M. No. 103	"	"	"	2.5 gr "	"	"
"	"	"	"	"	"	"	2.9 gr "	"	"
"	"	"	M. No. 105	11.2 ≠ equal quantity of water / 2 cooked flesh	Aug. 26 1935	10 hr 35 min	4.5 gr "	"	"
"	"	"	"	"	"	"	3.1 gr "	"	"

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Table 64 ohagurohata *Cephalopholis argus* Schneider

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9508 33.6 cm	Saipan	Aug. 26 1000	M. No. 86 right	1.8 + 1.8 liver	1019	19 min	0.4 gr 1455	no effect at 1458
"	"	"	M. No. 87	"	"	"	0.6 gr "	"
"	"	"	"	"	"	"	0.8 gr "	"
"	"	"	M. No. 85	4.6 + 4.6 ovary	1010	10 min	2.4 gr 1450	1450
"	"	"	"	"	"	"	1.8 gr "	"
"	"	"	M. No. 86 left	"	"	"	1.4 gr "	"
"	"	"	M. No. 88	0.5 + 0.5 blood	1024	24 min	0.1 gr "	1455
"	"	"	"	"	"	"	0.1 gr "	"

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Table 65 ohagurohata Cephalopholis argus Schneider

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
Unknown	Saipan	Sept. 17	M. No. 90 right	1 ≠ 1 liver	1445	" [Sic]	0.9 Sept. 18 1420	diarrhea
"	"	"	No. 91 left	"	"	"	0.8 gr "	no effect
"	"	"	" right	raw flesh (from dorsal side of head)	1450	"	1.0 "	"
"	"	"	No. 92 left	"	"	"	0.9 "	slight diarrhea
"	"	"	" right	" (from dorsal side of tail)	1500	"	1.1 gr "	"
"	"	"	No. 2 left	"	"	"	1.5 gr "	no effect
"	"	"	" right	cooked flesh (from dorsal side of tail)	1510	"	0.7 gr "	"
"	"	"	No. 2 left [sic]	"	"	"	1.0 gr "	"
"	"	"	" right	" (from dorsal side of head)	1515	"	0.5 gr "	"
"	"	"	No. 3 left	"	"	"	1.0 gr "	"

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Table 66 ohagurohata <u>Cephalopholis</u> <u>argus</u> Schneider

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9608 40 cm	Saipan	Sept. 19 2300	M. NO. 111	raw flesh (head)	Sept. 20 1500	16 hrs	2.0 gr Sept. 21 1540	no effect
"	"	"	"	"	"	"	" "	"
"	"	"	M. No. 112	raw flesh (tail)	"	"	2.0 gr "	"
"	"	"	"	"	"	"	" "	"
"	"	"	M. No. 115	cooked flesh (head)	Sept. 20 1510	16 hrs 10 min	2.5 gr "	diarrhea, listless
"	"	"	"	"	"	"	1.1 gr "	moribund
"	"	"	M. No. 116	cooked flesh (tail)	"	"	1.9 gr "	diarrhea
"	"	"	"	"	"	"	2.0 gr "	diarrhea

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Table 67 ohagurohata <u>Cephalopholis</u> <u>argus</u> Schneider

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9645 24 cm	Outside reef, Matansha area, Saipan	Sept. 19 2300	M. No. 105	raw flesh (side of head)	Sept. 20 1050	12 hrs	1.85 gr Sept. 20 1045	no effect
"	"	"	"	"	"	"	" "	"
"	"	"	M. No. 106	raw flesh (side of tail)	Sept. 19 1100 [Sic]	"	2.0 gr "	"
"	"	"	"	"	"	"	"	"
"	"	"	M. No. 113	cooked flesh (side of tail)	"	"	1.5 gr "	"
"	"	"	"	"	"	"	"	"
"	"	"	M. No. 114	cooked flesh (side of head)	"	"	1.9 gr "	"
"	"	"	"	"	"	"	2.0 gr "	"

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Table 68 obagurohata Cephalopholis argus Schneider

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weigh-ing remainder	Results	Notes
9608 40 cm	Saipan	Sept. 19	M. No. 120	dried flesh	Sept. 29 1110	9 days	0.1 gr	no effect	dried Sept. 19 at 1100
"	"	"	"	"	"	"	0.1 gr	"	"
"	"	"	M. No. 83	"	"	"	0.2 gr	"	dried Sept. 20 1530
"	"	"	"	"	"	"	"	"	"

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Table 69 ohagurohata <u>Cephalopholis</u> <u>argus</u> Schneider

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9708 40 cm	Jaluit	Nov. 2 1200	Cat No. 1	tail, raw	1500	3 hr	17 gr	diarrhea, at 0800 Nov. 4 locomotion somewhat impaired
"	"	"	Cat No. 2	head, cooked	"	"	2 gr	almost no effect, hind legs mildly affected
"	"	"	M. No. 89 left	tail, raw	"	"	2 gr	no effect
"	"	"	" right	head, cooked	"	"	2.5 gr	weakened
"	"	"	M. No. 90 left	1 ≁ 1 liver	"	"	2 gr	no effect

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Table 70 ohagurohata <u>Cephalopholis</u> <u>argus</u> Schneider

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9767 28 cm	Jaluit	Nov. 8	Cat No. 4	cooked side fillet	1300 [?]	----	27 gr	no effect

Table 71 akajin <u>Plectropomus</u> <u>truncatus</u> Fowler

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weigh-ing remainder	Results	Notes
9609 97.0 cm	Saipan	Sept. 19	M. No. 103	raw flesh (tail)	Sept. 20 1540	" [Sic]	2.8 gr Sept. 21 1615	diarrhea, listless, movements sluggish	sensory reactions not tested
"	"	"	M. No. 103	"	"	"	"	no effect	"
"	"	"	M. No. 104	raw flesh (head)	"	"	2.6 gr "	"	"
"	"	"	"	"	"	"	1.0 gr "	died, stomach contained sticky fluid, nc other apparent ill-effect	No. 5
"	"	"	M. No. 105	cooked flesh (head)	Sept. 20 1550	"	2.5 gr "	diarrhea, listless, movements sluggish	Sensory reactions no tested
"	"	"	"	"	"	"	2.8 gr "	no effect	"
"	"	"	M. No. 107	cooked flesh (tail)	"	"	2.5 gr "	"	"
"	"	"	"	"	"	"	1.9 gr "	"	"
"	"	"	M. No. 108	$\frac{2 \neq 2}{2}$ liver	Sept. 20 1600	"	0.9 gr "	"	"

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Table 72 akajin <u>Plectropomus truncatus</u> Fowler

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9609 97.0 cm	Saipan	Sept. 19	M. No. 108	$\frac{2 \neq 2}{2}$ liver	Sept. 20 1915	" [Sic]	1.3 gr Sept. 21 1615	no effect

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Table 73 akajin <u>Plectropomus truncatus</u> Fowler

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results	Notes
9609 97.0 cm	Saipan	Sept. 19	M. No. 82	dried flesh	Sept. 28 1100	--------	0.3 gr	no effect	dried 1530 Sept. 20
"	"	"	"	"	"	"	0.4 gr	"	

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Table 74 yogorehata Plectropomus sp.

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9745 35.9 cm	Jaluit	Nov. 5	Cat No. 1	head, cooked	Nov. 5 1400		33.7 gr	sensitive, no effect on movements
"	"	"	M. No. 69 left	"	"		" [Sic]	"
"	"	"	M. No. 90 right	tail, raw	"		"	"

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Table 75 amadaredokuhata _Plectropomus_ _oligacanthus_ Bleeker

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9730 52.6 cm	Jaluit	Oct. 31 0700	M. No. 112 right	1 ≠ 1 liver	0800		0.8 gr x 1/2 Nov. 1 0740	no effect
"	"	"	No. 105	raw (head)	"		2.2 gr "	senses and movements affected (0740 Nov. 1)
"	"	"	No. 106	tail, cooked	"		2.3 gr "	" moribund at 1331, died in the evening
"	"	"	Cat No. 9	head, raw	"		19 gr "	senses impaired, movements not affected, moribund 0700 Nov. 1, died in the evening
"	"	"	Cat No. 10	tail, cooked	"		21 gr "	died, progress of poisoning about the same as above

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Table 76 barahata *Variola louti* (Forskål)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results	Notes
9650 52.6 cm	Saipan	Sept. 16 1300	M. No. 99	flesh	1700	4 hrs	2.0 gr	no effect	outside reef off Oreai
"	"	"	"	"	"	"	2.0 gr	"	
"	"	"	No. 100	cooked flesh	"	"	1.2 gr	hair fell from head, listless, no movement	
"	"	"	"	"	"	"	1.3 gr	"	
"	"	"	Cat	"	"	"	50 gr	vomited half of amount eaten, listless, could walk if forced to but only lay down when left alone	

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Table 77 azukiganmo <u>Variola</u> sp.

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9776 35.0 cm	Jaluit	Nov. 8	Cat	cooked side fillet	1400 [?]	-----	35 gr	no effect

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Table 78 azukiganmo <u>Variola</u> sp.

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9585 36.8 cm	Jaluit	Nov. 5	Cat No. 5	cooked side fillet	---	-----	29.4 gr	no effect

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Table 79 madarahata Serranus fuscoguttatus (Forskål)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9607 53.1 cm	Saipan	Sept. 19	M. No. 113	raw flesh (head)	1500	-----	2.3 gr 1600	no effect
"	"	"	"	"	"	"	1.3 gr "	"
"	"	"	No. 114	" (tail)	"	"	3.0 gr "	"
"	"	"	"	"	"	"	0.9 gr "	"
"	"	"	No. 97	cooked flesh (head)	1515	"	2.5 gr "	diarrhea, slightly listless
"	"	"	"	"	"	"	2.5 gr "	"
"	"	"	No. 98	$\frac{3 \neq 3}{2}$ liver	1520	"	0.7 gr "	moribund, diarrhea, very listless
"	"	"	"	"	"	"	0.1 gr "	no effect
"	"	"	No. 99	cooked flesh (tail)	"	"	2.6 gr "	diarrhea
"	"	"	"	"	"	"	3.0 gr "	"

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Table 80 madarahata <u>Serranus</u> <u>fuscoguttatus</u> (Forskål)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results	Notes
9607 53.1 cm	Saipan	Sept. 19	M. No. 84	dried flesh	Sept. 28 1105		0.1 gr	no effect	dried Sept. 19 1100
"	"	"	"	"	"		0.2 gr	"	"

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Table 81 madarahata <u>Serranus</u> <u>fuscoguttatus</u> (Forskål)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9607 53.1 cm	Saipan	Sept. 19	M. No. 100	$\frac{3 \neq 3}{2}$ testis	1530		0.9 gr	no effect
"	"	"	"	"	"		1.5 gr	"

Table 82 yodarehata <u>Serranus</u> sp.

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9706 53.1 cm	Jaluit	Nov. 1 1200	Cat. No. 1	head, cooked	1400	2 hrs	30 gr	no effect at 1200 [Sic]
"	"	"	Cat No. 2	tail, raw	"	"	30 gr	"
"	"	"	M. No. 117 left	head, cooked	"	"	2.8 gr	"
"	"	"	" right	head, raw	"	"	2.2 gr	"
"	"	"	M. No. 118 left	tail, cooked	"	"	3.0 gr	"
"	"	"	" right	tail, raw	"	"	2.0 gr	"

Table 83 yodarehata *Serranus* sp.

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9644 55.5 cm	Saipan	Sept. 17 1020	M. No. 112	diver	1040	20 min	0.5 gr	no effect
"	"	"	"	"	"	"	0.5 gr	"
"	"	"	M. No. 86	raw flesh (dorsal side of tail)	1052	32 min	1.8 gr	"
"	"	"	M. No. 87 left	"	"	"	2.0 gr	"
"	"	"	" right	" (dorsal side of head)	1057	37 min	1.8 gr	"
"	"	"	M. No. 88 left	"	"	"	2.2 gr	"
"	"	"	" right	cooked flesh (dorsal side of tail)	1110	50 min	2.6 gr	"
"	"	"	No. 89 left	"	"	"	2.0 gr	some hair fell from head, listless
"	"	"	" right	" (dorsal side of head)	"	"	2.3 gr	no effect
"	"	"	No. 90	"	"	"	3.0 gr	"
"	"	"	Cat	raw flesh	"	"	32.2 gr	regurgitated whole feeding between 1400-1630, somewhat weakened

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Table 84 tsuchirohata <u>Serranus</u> <u>albofasciatus</u> (Lacépède)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9783 33.8 cm	Jaluit	Nov. 8	Cat	cooked side fillet	1400	-----	25 gr	no effect

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Table 85 nominokuchi <u>Serranus</u> <u>fario</u> (Thumberg)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9758 37.3 cm	Jaluit	Nov. 7 refrigerated for 6 days	Cat No. 13	head, raw	[?]	-----	27.0 gr	no effect
"	"	"	Cat No. 14	tail, raw	"	"	34.0 gr	no effect

Table 86 sazanamihagi <u>Ctenochaetus</u> <u>strigosus</u>

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
<u>Kuchiku</u> No. 1	Saipan St. I	Aug. 26 0900	M. No. 93 left	liver	0945	45 min	0.3 gr 1440	1440 no effect
	"	"	" right	"	"	"	0.2 gr "	"
	"	"	M. No. 94 left	"	"	"	0.3 gr "	"
	"	"	" right	$\frac{0.2 + 0.2}{2}$ blood and fishmeal	0950	50 min	0.2 gr "	"
	"	"	M. No. 95 left	"	"	"	0.1 gr "	"
	"	"	" right	2.1 + 2.1 flesh and fishmeal	1000	1 hr	0.3 gr 1450	1450 no effect
	"	"	M. No. 96 left	"	"	"	0.3 gr "	"
	"	"	" right	"	"	"	0.1 gr "	"
	"	"	M. No. 105 left	3g x $\frac{1}{2}$ flesh(cooked)	1037	1 hr 37 min	1.0 gr "	"
	"	"	" right	"	"	"	1.1 gr "	"

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Table 87 sazanamihagi <u>Ctenochaetus strigosus</u>

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results	
<u>kuchiku</u> No. 17	Saipan St. I	Sept. 26 [Sic] 0900	M. No. 104	flesh	1930	10 hr 30 min	1.0 gr 0830	evening of the 26th, no effect	1330 on the 27th, no effect
"	"	"	"	"	"	"	1.0 gr "	"	"
"	"	"	M. No. 107 right	flesh (cooked)	1940	10 hr 40 min	0.7 gr 0840 on the 27th	"	"
"	"	"	M. No. 108 left	"	"	"	"	"	"

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Table 88 sazanamihagi *Ctenochaetus strigosus*

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
kuchiku No. 3	Saipan St. 2	Aug. 27 1100	M. No. 105	$\frac{0.5 + 0.5}{2}$ liver and fishmeal	1355	2 hr 55 min	0.5 gr Aug. 27 1900	1900 no effect
	"	"	"	"	"	"	0.4 gr "	"
	"	"	M. No. 106	flesh	1356	2 hr 56 min	0.9 gr "	"
	"	"	"	"	"	"	0.7 gr "	"
	"	"	M. No. 101	flesh (cooked)	1410	3 hr 10 min	0.6 gr 1905	1910 no effect 1045 Aug. 29 no effect
	"	"	"	"	"	"	1.2 gr "	1910 no effect 1045 Aug. 29, listless

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Table 89 sazanamihagi *Ctenochaetus strigosus*

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
kuchiku No. 3	Saipan St. 2	Aug. 27 1100	M. No. 107	$\frac{1.5 + 1.5}{2}$ liver and fishmeal	1400	3 hr	0.8 gr 1900	1900 no effect
	"	"	"	"	"	"	"	"
	"	"	M. No. 108	flesh unmixed with fishmeal	1405	3 hr 5 min	0.9 gr "	"
	"	"	"	"	"	"	0.3 gr "	"
	"	"	M. No. 102	$\frac{3.6}{2}$ (raw weight) cooked flesh	1415	3 hr 15 min	0.6 gr 1910	no effect at 1910 found dead at 1045 Aug. 29
	"	"	"	"	"	"	0.5 gr "	" no effect

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Table 90 sazanamihagi <u>Ctenochaetus</u> <u>strigosus</u>

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results	
<u>kuchiku</u> No. 4	Saipan St. 2	Aug. 28 0830	M. No. 103	$\frac{0.5 \neq 0.5}{2}$ blood and fishmeal	0922	52 min, before rigor mortis	0.5 gr 1450	no effect at 1450	no effect at 1045 Aug. 29
	"	"	"	"	"	"	" "	"	at 1045 Aug. 29 listless, severe diarrhea
	"	"	M. No. 104	$\frac{1.10 \neq 1.10}{2}$ liver	0928	58 min	0.8 gr 1450	no effect at 1450	no effect at 1045 Aug. 29
	"	"	"	"	"	"	0.9 gr "	"	"
	"	"	M. No. 85	flesh, not mixed with fishmeal	0931	1 hr 01 min, before rigor mortis	0.8 gr "	"	"
	"	"	"	"	"	"	1.1 gr "	"	"
	"	"	M. No. 86	flesh (cooked)	0945	1 hr 15 min, before rigor mortis	2.0 gr 1445	slightly listless at 1045 Aug. 29	
	"	"	"	"	"	"	1.8 "	listless, diarrhea at 1045 Aug. 29	

Table 91 sazanamihagi *Ctenochaetus strigosus*

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results	
kuchiku No. 5	Saipan St. 2	Aug. 28 0830	M. No. 93	$\frac{3.1}{2}$ flesh(cooked)	1005	1 hr 50 min; before rigor mortis	1.5 gr 1500	no effect at 1500	1045 Aug. 29 listless diarrhea
	"	"	"	"	"	"	1.5 gr "	no effect at 1500	no effect
	"	"	M. No. 87	blood	0945	1 hr 15 min; before rigor mortis	0.5 gr 1450	diarrhea at 1450	1045 Aug. 29, listless
	"	"	"	"	"	"	0.5 gr "	"	"
	"	"	M. No. 117	$\frac{0.8 + 0.8}{2}$ liver	0950	1 hr 20 min; before rigor mortis	0.5 gr 1455	no effect at 1455	1045 Aug. 29 moribund
	"	"	"	"	"	"	0.4 gr "	no effect at 1455	1045 Aug. 29 listless
	"	"	M. No. 118	flesh (raw)	0951	1 hr 21 min; before rigor mortis	0.9 gr 1500	no effect at 1500	1045 Aug. 29, dead
	"	"	"	"	"	"	0.6 gr "	"	1045 Aug. 29 listless

Table 92 sazanamihagi <u>Ctenochaetus strigosus</u>

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results	
<u>kuchiku</u> No. 6	Saipan St. 2	Aug. 28 0900	M. No. 119	$\frac{1.2 + 1.2}{2}$ liver	1000	1 hr; before rigor mortis	0.8 gr 1500	1500 listless	1045 Aug. 29 listless
	"	"	"	"	"	"	0.6 gr "	"	"
	"	"	M. No. 94	flesh	1007	1 hr 7 min; before rigor mortis	1.5 gr 1500	1500 diarrhea	1045 Aug. 29 diarrhea listless
	"	"	"	"	"	"	1.1 gr "	1500 no effect	" diarrhea, listless
	"	"	M. No. 95	$\frac{3.70}{2}$ flesh(cooked)	1015	1 hr 15 min; before rigor mortis	1.7 gr "	"	" diarrhea, listless, died
	"	"	"	"	"	"	1.4 gr "	"	" listless, diarrhea
	"	"	M. No. 96	$\frac{0.8 + 0.8}{2}$ blood and fishmeal	"	"	0.7 gr "	" diarrhea	" listless
	"	"	"	"	"	"	" "	" "	" "

Table 93 sazanemihagi *Ctenochaetus strigosus*

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
kuchiku No. 7	Saipan St. 2	Aug. 28 0930	M. No. 113	$\frac{1 \not{} 1}{2}$ liver and fishmeal	1025	55 min; before rigor mortis	0.7 gr 1505	1505 diarrhea; 1030 Aug. 29 listless, hair fell from head
	"	"	"	"	"	"	0.9 gr "	" diarrhea; 1030 Aug. 29 listless, hair fell from head, dead at 1530
	"	"	M. No. 114	flesh, not mixed with fishmeal	1030	1 hr; before rigor mortis	0.9 gr 1510	1510; 1030 Aug. 29 diarrhea, hair fell from head
	"	"	"	"	"	"	0.8 gr "	1510 diarrhea; "
	"	"	M. No. 5	$\frac{2.8}{2}$ flesh(cooked)	1045	1 hr 15 min; before rigor mortis	1.3 gr 1515	1515 no effect; 1030 Aug. 29 dead
	"	"	"	"	"		"	"; 1030 Aug. 29 listless, hair fell from head

Table 94 sazanamihagi *Ctenochaetus strigosus*

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results	
kuchiku No. 8	Saipan St. 2	Aug. 29 1500	M. No. 93	$\frac{1.8 + 1.8}{2}$ liver and fishmeal	1630	1 hr 30 min	0.8 gr 0945 Aug. 30	0945 Aug. 30 no effect	1900 Aug. 30 no effect
	"	"	"	"	"	"	1.2 gr "	"	"
	"	"	M. No. 94	flesh (raw)	1640	1 hr 40 min	2.0 gr 0950 Aug. 30	0950 Aug. 30 no effect	
	"	"	"	"	"	"	0.5 gr "	"	
	"	"	M. No. 95	$\frac{3.5}{2}$ flesh(cooked)	"	"	1.2 gr 1053	1053 no effect	1900 no effect
	"	"	"	"	"	"	1.6 gr "	listless	"
	"	"	M. No. 96	$\frac{0.4 + 0.4}{2}$ blood and fishmeal	1500 [Sic]	"	0.4 gr 1053	1053 listless	1400 slightly listless
	"	"	"	"	"	"	" "	no effect	no effect

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Table 95 sazanamihagi *Ctenochaetus strigosus*

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
kuchiku No. 9	Saipan St. 3	Aug. 30 1330	M. No. 118	flesh (raw)	1505	1 hr 35 min; before rigor mortis	0.3 gr 0950	0950 slightly listless
	"	"	"	"	"	"	1.6 gr "	"
	"	"	M. No. 117	$\frac{1.1 + 1.1 + 1.1}{2}$ liver, tapioca fishmeal	1500	1 hr 30 min; before rigor mortis	1.6 gr 0950	0950 listless
	"	"	"	"	"	"	1.0 gr "	"
	"	"	M. No. 82	$\frac{49}{2}$ (raw weight) cooked flesh	1615	2 hr 15 min; before rigor mortis	2.0 gr 1010	1010 no effect
	"	"	"	"	"	"	1.7 gr "	" slightly listless

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Table 96 sazanamihagi <u>Ctenochaetus strigosus</u>

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
kuchiku No. 10	Saipan St. 3	Aug. 30 1330	M. No. 119	$\frac{1.5 \neq 3}{2}$ liver & tapioca	1520	1 hr 50 min; before rigor mortis	0.9 gr	listless
	"	"	"	"	"	"	"	"
	"	"	M. No. 114	flesh	1600	2 hr 30 min; before rigor mortis	2.3 gr	"
	"	"	M. No. 114	"	"	"	2.0 gr "	"
	"	"	M. No. 83	flesh(cooked)	1615	2 hr 45 min; before rigor mortis	2.8 gr 1010	1010 no effect
	"	"	"	"	"	"	2.6 gr "	"

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Table 97 sazanamihagi *Ctenochaetus strigosus*

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
kuchiku No. 11	Saipan St. 3	Aug. 30 1330	M. No. 89	$\frac{6.7}{2}$ flesh	1530	2 hrs; before rigor mortis	1.3 gr 1000	1000 no effect
	"	"	"	"	"	"	1.6 gr "	" "
	"	"	M. No. 120	$\frac{2.5 + 2.5}{2}$ liver and fishmeal	1525	1 hr 55 min; before rigor mortis	1.4 gr 1000	" "
	"	"	"	"	"	"	1.3 gr "	" slightly listless
	"	"	M. No. 84	$\frac{3.8}{2}$ (raw weight) Cooked flesh	1620	2 hr 50 min; before rigor mortis	1.9 gr 1010	1010 no effect
	"	"	"	"	"	"	"	" slightly listless

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Table 98 sazanamihagi *Ctenochaetus strigosus*

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
kuohiku No. 12	Saipan St. 3	Aug. 30 1330	M. No. 91	$\frac{2.2 + 2.2}{2}$ liver and fishmeal	1540	2 hr 10 min; before rigor mortis	1.6 gr 1000	1000 listless
	"	"	"	"	"	"	0.9 gr "	" "
	"	"	M. No. 90	flesh	1535	2 hr 05 min; before rigor mortis	1.7 gr 1000	1000 no effect
	"	"	"	"	"	"	2.3 gr "	" slightly listless
	"	"	M. No. 101	$\frac{5.2}{2}$ (raw weight) cooked flesh	1625	2 hr 55 min; before rigor mortis	2.3 gr 1015	1015 slightly listless
	"	"	"	"	"	"	2.2 gr "	" no effect

Table 99 sazanamihagi *Ctenochaetus strigosus*

Serial No. & length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
kuchiku No. 13	Saipan St. 3	Aug. 30 1330	M. No. 113	$\frac{2.7 + 2.7}{2}$ liver and fishmeal	1550	2 hr 20 min; before rigor mortis	1.6 gr 1005	1005 listless
	"	"	"	"	"	"	1.0 gr "	" no effect
	"	"	M. No. 92	$\frac{6.2}{2}$ flesh	1545	2 hr 15 min; before rigor mortis	1.3 gr 1000	1000 listless
	"	"	"	"	"	"	1.2 gr "	" slightly listless
	"	"	M. No. 102	$\frac{6.5}{2}$ (raw weight) cooked flesh	1630	3 hr; before rigor mortis	2.6 gr "	no effect
	"	"	"	"	"	"	3.25 gr "	slightly listless

Table 100 sazanamihagi *Ctenochaetus strigosus*

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
kuchiku No. 14 9641 20 cm	inside reef off Saipan	Sept. 17 0900	M. No. 114	$\frac{0.8 + 0.8}{2}$ liver and fishmeal	0908	8 min	0.7 gr Sept. 18 1400	no effect
"	"	"	"	"	"	"	0.6 gr "	"
"	"	"	M. No. 115	raw flesh (dorsal side of tail)	0915	15 min	0.5 gr "	"
"	"	"	"	"	"	"	" "	"
"	"	"	M. No. 116	" (dorsal side of head)	"	"	1.4 gr "	"
"	"	"	"	"	"	"	1.5 gr "	slight diarrhea
"	"	"	M. No. 81	" (ventral side of tail)	0920	20 min	0.9 gr "	a little hair fell from head, slightly listless
"	"	"	"	"	"	"	0.7 gr "	no effect

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Table 101 sazanamihagi <u>Ctenochaetus</u> <u>strigosus</u>

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
kuchiku No. 14 9641 20 cm	inside reef off Saipan	Sept. 17 0900	M. No. 102	cooked flesh (dorsal side of head)	1000	1 hr	1.2 gr Sept. 18 1510	slight diarrhea
"	"	"	"	"	"	"	1.2 gr "	testes descended and enlarged
"	"	"	M. No. 103	" (ventral side of tail)	"	"	1.6 gr "	no effect
"	"	"	"	"	"	"	1.1 gr "	dead at 1510
"	"	"	M. No. 104	" (dorsal side of tail)	"	"	0.6 gr "	no effect
"	"	"	"	"	"	"	" "	"

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Table 102 sazanamihagi <u>Ctenochaetus</u> <u>strigosus</u>

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
<u>kuchiku</u> No. 15 9642 20 cm	inside reef off Saipan	Sept. 17 0900	M. No. 82	raw flesh (dorsal side of head)	0930	30 min	1.0 gr Sept. 18 1410	slight diarrhea
"	"	"	"	"	"	"	1.0 gr "	"
"	"	"	M. No. 83	$\frac{1 \neq 1}{2}$ liver	0940	40 min	0.9 gr "	"
"	"	"	"	"	"	"	" "	"
"	"	"	M. No. 84	raw flesh (ventral side of tail)	0950	50 min	1.0 gr "	"
"	"	"	"	"	"	"	" "	"
"	"	"	M. No. 101	"	"	"	0.7 gr "	no effect
"	"	"	"	"	"	"	" "	"

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Table 103 sazanamihagi *Ctenochaetus strigosus*

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
kuchiku No. 16 9643 18 cm	inside reef off Saipan	Sept. 17 0900	M. No. 105	1 ∤ 1 / 22 liver	1015	1 hr 15 min	0.8 gr Sept. 18 1500	no effect
"	"		"	"	"	"	0.9 gr "	diarrhea, slightly listless
"	"		M. No. 109	raw flesh (dorsal side of head)	1030	1 hr 30 min	0.7 gr "	no effect
"	"		"	"	"	"	" "	"
"	"		M. No. 110	" (ventral side of tail)	"	"	0.8 gr "	"
"	"		"	"	"	"	" "	"
"	"		M. No. 111	" (dorsal side of tail)	1040	1 hr 40 min	0.45 gr "	"
"	"		"	"	"	"	0.5 gr "	"

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Table 104 sazanamihagi Ctenochaetus strigosus

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
kuchiku No. 15 9642 20 cm	inside reef off Saipan	Sept. 17 0900	M. No. 106	cooked flesh (ventral side of tail)	1020	1 hr 20 min	0.6 gr Sept. 18 1510	no effect
"	"	"	"	"	"	"	"	"
"	"	"	M. No. 107	" (dorsal side of head)	1025	1 hr 25 min	1.0 gr "	"
"	"	"	"	"	"	"	"	"
"	"	"	M. No. 108	" (dorsal side of tail)	"	"	0.6 gr "	"
"	"	"	"	"	"	"	"	"

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[Translator's note: In the entries below the notation, "no effect except diarrhea," may be s misprint for "listless, diarrhea."]

Table 105 kawarisazanamihagi <u>Ctenochaetus</u> sp.

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9680 28 cm	Jaluit	Oct. 26 1000	Cat No. 1	tail, raw	1205	2 hr 05 min	31.3 gr	1800 Oct. 26 no effect except diarrhea C610 Oct. 27 movement of hind legs impaired, senses dulled
"	"	"	Cat No. 2	back and belly flesh, raw	"	"	35.3 gr	1800 Oct. 26 no effect except diarrhea 0610 Oct. 27 locomotory and sensory functions impaired in hind legs
"	"	"	Cat No. 3	tail, cooked	"	"	34.4 gr	1800 Oct. 26 no effect except diarrhea Rollen [Sic] 0610 Oct. 27 movement of hind legs impaired, senses dulled
"	"	"	Cat No. 4	back and belly flesh, cooked	"	"	45.2 gr	1800 Oct. 26 no effect except diarrhea 0610 Oct. 27 walking difficult, senses dulled
9681 25 cm	Jaluit	"	M. No. 9	1 ≠ 1 (raw) liver	1240	2 hr 40 min	0.5 gr	1800 Oct. 26 no effect 0610 Oct. 27 no effect
"	"	"	M. No. 10	"	"	"	0.9 gr	" "
"	"	"	M. No. 11	"	"	"	1.1 gr	" "
"	"	"	M. No. 12	tail, raw	"	"	1.1 gr	" "
"	"	"	M. No. 17	back and belly flesh, raw	"	"	2.0 gr	" 0610 Oct. 27 movements somewhat sluggish, walking difficult

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Table 106 kawarisazanamihagi <u>Ctenochaetus</u> sp.

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9681 25 cm	Jaluit	Oct. 26 1000	M. No. 20	brain cooked	1240	2 hr 40 min	0.1 gr	no effect
"	"	"	M. No. 18	back and belly flesh (cooked)	"	"	2.0 gr	Oct. 26 no effect Oct. 27 "
"	"	"	M. No. 19	tail (cooked)	"	"	1.7 gr	Oct. 26 " Oct. 27 walking difficult

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Table 107 kawarisazanamihagi <u>Ctenochaetus</u> sp.

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9682 26 cm	Jaluit	Oct. 26 1000	Cat No. 5	tail, cooked	1335	3 hr 35 min	28.7 gr	walking difficult, could not move hind legs, senses dulled

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Table 108 kawarisazanamihagi *Ctenochaetus* sp.

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9684 21 cm	Jaluit	Oct. 26 1000	Cat No. 6	back and belly flesh (cooked)	1335	3 hr 35 min	13.4 gr	lively
"	"	"	Cat No. 7	tail (raw)	"	"	12.0 gr	"

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Table 109 raidenhagi <u>Zebrasoma</u> <u>veliferum</u> (Bloch)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weigh-ing remainder	Results
9799 28 cm	Saipan	Sept. 11 0800	M. No. 81	1 + 1 liver	0930	1 hr 30 min	0.8 gr	listless
"	"	"	"	ovary	0935	1 hr 35 min	0.3 gr	"
"	"	"	M. No. 82	raw flesh from back	0945	1 hr 45 min	0.3 gr	no effect
"	"	"	"	"	"	"	0.8 gr	"
"	"	"	M. No. 87	cooked flesh from belly	"	"	0.5 gr	"
"	"	"	"	"	"	"	"	"

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Table 110 raidenhagi <u>Zebrasoma</u> <u>veliferum</u> (Bloch)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9798 25 cm	Saipan	Sept. 11 0800	M. No. 83	raw flesh	1000	2 hr 02 min	0.5 gr 1515	1515 no effect
"	"	"	"	"	"	"	0.3 gr "	"
"	"	"	M. No. 84	liver	1005	2 hr 05 min	0.1 gr "	"
"	"	"	"	"	"	"	0.7 gr "	"
"	"	"	M. No. 85 left	raw flesh	"	"	1.0 gr "	"
"	"	"	"	"	"	"	1.8 gr "	"

Table 111 raidenhagi <u>Zebrasoma veliferum</u> (Bloch)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9797 20 cm	Saipan near Gunkan I.	Sept. 11 0800	M. No. 86	cooked flesh, back	1030	2 hr 30 min	cooked 2.4 gr Sept. 12 0900	Sept 12 0900 somewhat listless
"	"		"	"	"	"	" "	"
"	"		M. No. 88	cooked flesh, belly	"	"	cooked 1.5 gr "	somewhat listless
"	"		"	"	"	"	" "	no effect
"	"		M. No. 93	raw flesh, belly	"	"	" "	"
"	"		"	"	"	"	" "	"
"	"		M. No. 94	raw flesh, back	"	"	2.0 gr "	listless
"	"		"	"	"	"	1.5 gr "	no effect
"	"		M. No. 95	1 ≠ 1 liver	1045	"	1.0 gr "	"

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Table 112 raidenbagi <u>Zebrasoma</u> <u>veliferum</u> (Bloch)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
9797 20 cm	Saipan near Gunkan I.	Sept. 11 0800	M. No. 95	1 ≠ 1 liver	1045	2 hr 45 min	1.0 gr Sept. 12 0900	no effect

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Table 113 raidenhagi <u>Zebrasoma</u> <u>veliferum</u> (Bloch)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & time of weighing remainder	Results
9759 23 cm	Jaluit	Nov. 7	Cat No. 15	head, cooked	Nov. 7 0700		23.0 gr	no effect
"	"	"	Cat No. 16	tail, raw	"		25.0 gr	"

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Table 114 akahamongara <u>Odonus niger</u> (Rüppell)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9770 21.5 cm	Jaluit	Nov. 8	Cat No. 2	side fillet, cooked	0600		16.5 gr	could not move hind legs nor stand up

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Table 115 kiberimongara <u>Balistes flavimarginatus</u> Rüppell

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9715 28.2 cm	Jaluit	Nov. 5	Cat No. 1	tail, raw	0700		30 gr	no effect
"	"	"	Cat No. 2	head, cooked	"		38 gr	"

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Table 116 hoshinamihagi __Aleuteres__ __scriptus__ Osbeck

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
8567 54.8 cm	Saipan	Sept. 11 0800	M. No. 96	raw flesh, back	1050	2 hr 50 min	2.0 gr Sept. 12 0900	0900 Sept. 12 no effect
"	"		"	"	"	"	1.5 gr "	"
"	"		M. No. 113	1 ≠ 1 intestinal contents	1100	3 hr	0.3 gr "	"
"	"		"	"	"	"	" "	"
"	"		M. No. 114	1 ≠ 1 liver	"	"	1.4 gr "	"
"	"		"	"	"	"	1.0 gr "	"

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Table 117 hoshinamihagi _Aleuteres_ _scriptus_ Osbeck

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9565 53 cm	Saipan near Gunkan I.	Sept. 11 0800	M. No. 115 left	1 ≠ 1 liver	1400	6 hr	1.0 gr Sept. 12 0900	no effect
"	"	"	M. No. 115 right	raw flesh, back	"	"	1.0 gr "	"
"	"	"	M. No. 116	"	"	"	2.0 gr "	"
"	"	"	"	"	"	"	" "	"
"	"	"	M. No. 110	cooked flesh, back	"	"	1.0 gr "	"
"	"	"	"	"	"	"	1.9 gr "	"

Table 118 hoshinamihagi <u>Aleuteres</u> <u>scriptus</u> Osbeck

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9564 60 cm	Saipan near Gunkan I.	Sept. 11 0800	M. No. 109	1 ≠ 1 liver	1400	6 hr	1.1 gr Sept. 12 0900	0900 Sept. 12 no effect
"	"	"	"	"	"	"	1.5 gr "	"
"	"	"	M. No. 111	raw flesh	1420	6 hr 20 min	0.6 gr "	"
"	"	"	M. No. 111	"	"	"	1.1 gr "	"
"	"	"	M. No. 112	cooked flesh	"	"	1.6 gr "	"
"	"	"	"	"	"	"	2.3 gr "	"
"	"	"	M. No. 101	1 tapioca ≠ 1 fishmeal (control	1500	7 hr	" "	"
"	"	"	"	"	"	"	1.5 gr "	"
"	"	"	no mouse, evaporation test lot	raw flesh	1530	7 hr 30 min	2 gr - 0.5 gr	determined amount of evaporation in same period of time
"	"	"	"	"	"	"	2 gr - 0.6 gr	"

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Table 119 kihachijō <u>Holacanthus</u> <u>diacanthus</u> Günther

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9747 16.5 cm	Jaluit	Nov. 5	Cat	side fillet, cooked	Nov. 6 0200 [?]		14.7 gr	movements of hind legs appeared slightly affected, no sensory impairment

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Table 120 kobansuzumedai <u>Abudefduf</u> <u>sexfasciatus</u> (Lacépède)

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9750 9.8 cm	Jaluit	Nov. 5	M. No. 89 left	head, cooked	Nov. 5 1400		1.2 gr	whiskers drooped somewhat, no sensory or locomotory impairment
"	"	"	M. No. 89 right	tail, raw	"		1.2 gr	"

Table 121 yokoshimafugu Tetraodon hispidus Linné

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9521 26 cm	Saipan St. 2	Aug. 28 1015	mouse	blood mixed with equal quantity of fishmeal	Aug. 28 1040	35 min	0.5 gr 1515	no effect
"	"	"	"	"	"	"	0.4 gr "	"
"	"	"	"	liver mixed with equal quantity of fishmeal	Aug. 28 1043	38 min	1 gr "2	1515 listless, hair falling from head
"	"	"	"	"	"	"	1.2 gr "	"
9654 25 cm	" St. 3	Sept. 18 1200	"	blood mixed with equal quantity of fishmeal	Sept. 18 1625	4 hr 25 min	0.4 gr "	no effect
"	"	"	"	"	"	"	0.8 gr "	"
"	"	"	"	liver mixed with equal quantity of fishmeal	1630	4 hr [Sic]	0.5 gr "	"
"	"	"	"	"	"	"	0.3 gr "	moribund (1500 Sept. 19) dissected, some contents in stomach, stomach walls congested
"	Jaluit	Nov. 14	Cat	muscle tissue	" [Sic]	" [Sic]	30 gr	no effect

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Table 122 mizorefugu *Tetraodon meleagris* Bloch & Schneider

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9545 26 cm	Saipan St. 2	Aug. 29 1530	mouse	liver with equal amount of fishmeal	1715	1 hr 45 min	0.0 gr 2155	no effect
"	"	"	"	"	"	"	0.8 gr "	listless
"	"	"	"	"	"	"	2.2 gr "	"

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Table 123 yogorefugu <u>Tetraodon</u> <u>nigropunctatus</u> Bloch & Schneider

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9511 25 cm	Saipan St. 2	Aug. 29 1530	mouse	liver mixed with an equal amount of fishmeal	1530	0 hr 0 min	0.9 gr 2100	listless
"	"	"	"	"	"	"	1.5 gr "	"
"	"	"	"	"	"	"	1.5 gr "	"
9561 26 cm	" St. 3	Aug. 30 1540	"	"	1600	20 min	1.3 gr 2210	"
"	"	"	"	"	"	"	2.0 gr "	listless, weakened
"	"	"	"	"	"	"	1.0 gr "	no effect
"	"	"	"	"	"	"	1.2 gr "	listless, weakened
9651 26 cm	Saipan	Sept. 18 1200	"	blood mixed with an equal amount of fishmeal	1620	4 hr 20 min	0.7 gr Sept. 19 1500	no effect
"	"	"	"	"	"	"	0.7 gr "	"

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Table 124 yogorefugu <u>Tetraodon</u> <u>nigropunctatus</u> Bloch & Schneider

Serial No. & Length of Fish	Where Taken	Date and Time Taken	Animal Used	Part of Fish & Method of Preparation	Time of Feeding	Freshness (time since capture)	Amt. eaten & Time of weighing remainder	Results
9651 26 cm	Saipan St. 3	Sept. 18 1200	mouse	blood (control portion) for measuring evaporation	1605	4 hr 5 min	1.0 gr - 0.5 gr Sept. 19 1500	control for determining loss by evaporation
"	"	"	"	liver with an equal quantity of fishmeal	1620	4 hr 20 min	0.2 gr "	listless
"	"	"	"	"	"	"	0.8 gr "	"

1934

Report of an Investigation of Poisonous Fishes within the jurisdiction of the Saipan Branch of the Government-General

Foreword

I was recently ordered by the South Seas Government-General to undertake a study of about one month's duration of the poisonous fishes within the area under the jurisdiction of the Saipan Branch of the Government-General. I was not competent to undertake such a task, and of course it hardly need be said that it was impossible to settle such a great problem by an investigation covering such a limited period of time, however, I did as I was ordered without considering my lack of qualifications.

On September 17, 1934, I sailed from Yokohama for Saipan, and I returned to Tokyo on October 14 of the same year. About two weeks passed between the receipt of my orders and my departure and during that time I endeavored to assemble reference material concerning the investigation, but all I could find was the "Report of a Study of the Poisonous Fishes of Jaluit" by Dr. Ryūichi Matsuo of the South Seas Government-General's Clinic. Perhaps it may be said that there was no other literature on the subject.

My investigations were mainly centered at Saipan for the reason that at Tinian and Rota the facilities for such a study were lacking. The period of the investigation was during the rainy season and day after day there were innumerable rain squalls. The sea was rough and the collection of materials and other phases of the work did not go as expected. That I was consequently unable to execute fully the task assigned to me is a matter for deep regret.

I hope that it will be understood at the start that in the preparation of this manuscript it was unavoidable that many parts of it should be incomplete and imperfect. If I am fortunate enough to be granted the opportunity I would like to make up for these shortcomings in a later study.

March, 1935
Tokyo Imperial University
Contagious Disease Research Institute
Department of Immunology

Takashi Yasukawa

As commonly used the term "poisonous fish" has a very broad meaning and there is no apparent agreement among the various interpretations of it. I consider it proper to interpret the term as having a general application to all species which have poisonous substances contained in their bodies and which directly harm the human body, whether by the contact of their bodies or by the eating of their flesh or viscera either fresh or some time after their death. These fishes fall naturally into two categories depending on the location of the poisonous substances in their bodies. The first type includes those species which take some positive protective action. Their poison is contained in special spaces at the bases of the fin spines and is injected into the victim by the action of muscles when the spines are touched. Poisons of this type may be very violent, but the flesh of such fishes causes no reaction whatever.

The second type are fishes in which the protective function is passive. These are the species which are commonly called "poisonous fish". If the flesh of these fishes is eaten, poisoning results and in many cases it is fatal. The location of the poisonous element varies somewhat in different species, but it is chiefly found in the gonads, particularly in the ovaries, or sometimes in the liver. For this reason if sufficient care is taken in preparing the fish for the table, the flesh may be eaten without any ill effects. The poison in these fishes is not produced until the fish reaches maturity and is most violent in its action during the spawning season.

My orders were to investigate the fishes in the latter category. Present-day organic chemistry cannot provide any satisfactory answers regarding the poisonous elements in these fishes. None of the characteristics of their composition have been made clear. Among past studies of poisonous fishes are the following on the balloonfish, which has been known in Japan since ancient times: in 1889 Takahashi and Inoko studied the symptoms of poisoning in animals and investigated methods of isolating the poison. Later Dr. Narumi Inoue studied the curative properties of the poison, and in recent years Dr. Fusao Ishihara made a physiological study of balloonfish poison. Dr. Ryojun Tahara succeeded in refining balloonfish poison and it is employed as a medicine at present under the name of "Tetrodotoxin."

It is not very widely known that among the fishes of the tropics, particularly among salt-water fishes, there are many that are poisonous. The only study of such fishes of which we have any knowledge is the 1925 report by Ryūichi Matsuo from Jaluit I. which was mentioned above. For seven months beginning in August, 1924, Matsuo utilized his leisure from his medical duties to make a detailed study, but he did not succeed in clarifying the problem.

In the report of marine biological researches aboard the special duty vessel Kōshū in the South Sea Islands in 1933 it was noted that "In the Caroline Islands there are no poisonous fishes except the balloonfish. Fish taken by angling from the ship were eaten, after being identified by the Fisheries Experiment Station of the Government-General, and no cases of poisoning resulted." Dr. Amemiya (1921) has reported on fishes with poisonous spines.

Thinking that the only way I could operate would be to observe the actual conditions in the field and then bring back with me the materials for my experiments, I took along with me some of the instruments and chemicals which would be needed in the experiments. [TN !] In the tropics it is particularly essential that dissections of fishes be carried out with the utmost expedition,

but because of the lack of assistance I was unable to make fully detailed observations. As for chemical investigations of the poison, these could not be done in the field and naturally changes took place in the materials. This was the most difficult point in the investigation.

I wish to express my thanks to Governor-General Hayashi for the opportunity to make this study, and to Mr. Fushida, Chief of the Saipan Branch, and Administrative Officer Kurushima for the facilities which they placed at my disposal. Sincere thanks are also due to Technician Yamanaka, Chief of the Productive Industries Section, for taking time from his many duties to give me guidance and assistance. I wish also to thank Technician Marukawa of the Fisheries Experiment Station of the Ministry of Agriculture and Forestry and Dr. Wakiya, former Chief of the Korean Government-General Fisheries Experiment Station, for their valuable advice and assistance in locating the literature on the subject, and Mr. Miyakawa, head of the Contagious Disease Research Institute, and Dr. Toyama, head of the Immunology Section, for their kind consideration, as well as Dr. Hosotani for his advice on the poison experiments.

1. Fishermen's Reports

In beginning the investigation I thought that it would be a good idea to get the opinions of the fishermen, who are in direct and intimate touch with the problem, and then to use the information gained from them as a basis for my studies. Through the good offices of Technician Yamanaka I was able to talk with fishermen, ask them various questions, and obtain material for my study. The following are their replies to my inquiries:

(1) Kinds of poisonous fish

> <u>akamasu</u> (resembles the sea-bream), <u>ōmachi</u>, <u>ōhiraaji</u> [<u>Caranx</u> sp.]
> <u>unagi</u> (<u>utsubo</u>) [moray eel], <u>ōkamasu</u> [barracuda], <u>ōmebaru</u>
> <u>kuchiku</u> (resembles a black monacanthid), balloonfish

The moray eel is very dangerous and from time to time people die of eating it. There were also said to be other dangerous species the names of which were not known.

(2) Habitats of poisonous fish

In general fish which live outside the reefs are dangerous. In the case of the <u>kuchiku</u>, those taken in the vicinity of the government pier and south toward Charankanoa are dangerous, but those taken near the breakwater are safe to eat, it was reported. At Tinian also the fish from outside the reef are dangerous, it was said.

(3) Distinctions based on form and coloration

It is difficult to distinguish poisonous fishes by their form and coloration, but they are generally large. It is said that even in a poisonous species the small specimens may be nonpoisonous.

(4) Relationship of toxicity to food

It is said that the fish become poisonous through eating crabs, and some

also say through eating poisonous seaweeds. Some ascribe the toxicity to a weed which grows on the reef rocks. There is no agreement on these points and these beliefs appear to be without any foundation.

(5) Relationship of toxicity to spawning

Completely unknown

(6) Seasonal toxicity

There is no seasonal variation with such species as the akamasu and the moray eels. Nothing is known regarding other species.

(7) Effect of cooking

Eating the fish raw is said to produce a comparatively milder degree of poisoning.

(8) Differences in toxicity from island to island

The akamasu is said to be safe to eat at Yap, Truk, and Palau, where it is the most highly prized of foodfish. The fishermen say that fish taken inside the harbor are safe while those taken outside the harbor are dangerous. Administrative Officer Kurushima said that at Palau, Yap, Ponape, Truk, and Kusaie there are no poisonous fish, and that Jaluit has the greatest number of poisonous species.

I began my work with the above facts as a general basis, however, these were all reports picked up at random from various persons and their origins were unknown.

According to Matsuo's report, of all the South Sea Islands Jaluit has the greatest abundance of poisonous fish. Out of about 180 species occurring in the waters around Jaluit approximately 36, or one in five, are poisonous. It is not known, however, why these fishes contain poison.

The majority of cases of poisoning result from absorption of poison through the digestive organs. The symptoms are in general like those produced by balloonfish poisoning in Japan. These symptoms vary in severity, but in serious cases there is sensory and locomotory paralysis and death often results. The symptoms produced in dogs, cats, and pigs are milder than those seen in humans, and in chickens they are even less severe, it is said.

2. Ecology and Distribution of Poisonous Fishes

Poisonous fishes generally live in schools. They are not found in coastal waters where there is no seaweed on the bottom, and they do not occur far from the coast. South of the government pier along the coast of South Garapan there is a great deal of weed resembling akamo, and north of the Nankō Fishing Company's pier along the coast of Pontamuchau there is a profuse growth of a seaweed resembling the aosa. The bottom is almost all covered with broken fragments of coral and is white so that it reflects the light and makes the water appear a beautiful blue color. There are coral ridges here and there which have a considerable growth of weed. The fish assemble around these places and eat ______. No other type of food is apparent in these areas. As for the distribution of the fish, large individuals of such large species

as the akamasu, ōhiraaji, and ōmachi are almost always found outside the reef, although from time to time they come inside in pursuit of reef-fishes. The moray eels, mebaru, kuchiku, and balloonfish occur in large numbers inside the reef. Morays are more abundant in the northern half of the area while the kuchiku occurs more abundantly in the southern half. The east coast of the island has a high surf and is dangerous so the investigations had to be confined to the western shores.

3. Views on the Dissection of Poisonous Fishes

Method of collection. The fish were collected in depths of several fathoms and were all taken with a spear. Consequently the heads or bellies were damaged and this made it difficult to examine the organs properly when the fish were dissected.

(1) kuchiku

Stomach contents ... gravel (coral fragments) only, slight indications that seaweed had been eaten. Gonads immature.

(2) akamasu

Stomach contents ... Miscellaneous small fish which were almost completely digested and therefore shapeless. Gonads immature.

(3) Balloonfish

Stomach contents ... gravel only
Gonads ... immature

(4) Moray eel

Stomach contents ... Small fish had been eaten but they were unrecognizable
Gonads ... Some specimens were seen which had rather ripe gonads.

In addition to these species some foodfishes such as the muro and the ojisan (a goatfish) were dissected for purposes of comparison.

Muroaji [Decapterus sp.]

Stomach contents ... In most cases the stomach was almost empty.
Gonads ... Immature

Ojisan (Goatfish)

Stomach contents ... Miscellaneous small fish
Gonads ... Some specimens had rather ripe gonads.

In general the examination of the stomach contents of these fishes showed almost nothing which could be thought to be food. Most of the stomachs were filled with broken fragments of coral and small fish were encountered only rarely. Observations of the sea bottom showed that it was as clean swept as a park and as bare as a desert with nothing in sight which could serve as food. The relationship between the fishes and the plankton could not be investigated because of the lack of facilities. The season for the ripening of the gonads differs, of course, between different species, but in most of the poisonous species the gonads were immature.

4. Bacteriological Investigations of Poisonous Fishes

The toxicity of poisonous fishes is not due to bacteria. It was, of course, hardly necessary for me to confirm the fact that the poison resulting from putrefaction after death is due to bacterial action, but as I was ordered to do so I performed the following experiment. The materials used were eight kuchiku, three morays, and three balloonfish. As controls three goatfish and three *Decapterus* sp. were used, making a total of twenty fish employed in the experiment.

The fish were first opened up with a sterilized scalpel and scissors and all of the viscera were removed. A platinum wire was then used to plant cultures on both Endō plates and agar plates. The cultures were left at room temperature (26° average) for twenty-four hours.

Almost no bacterial colonies were seen in the cultures from the livers, gonads, kidneys, and muscles. The colonies which were seen developed on the cultures from the inside of the intestines. In general definite colonies were formed. When a microscopic examination was made of colonies which were thought to differ, twenty-five stocks were distinguished [?].

These bacteria were in general glossy bacilli which did not turn the Endō medium red. They were Gram-negative and most of them possessed mobility. Few of them broke down lactose, and although they broke down grape sugar they did not generate gas. Seven strains broke down glucose. Few of them coagulated milk, eight strains liquefied gelatine, and none of them formed indol.

From these results it was not possible to detect any strains of bacteria peculiar to poisonous fishes.

After the bacteria were isolated they were cultured through four -- five generations (transplanted once every three weeks) on agar slopes. These cultures were used in experiments on representative experimental animals. The fluid used in the innoculations was prepared by floating the requisite amount of bacteria from a culture grown on an agar slope for 20 hours at 37°C. in a physiological saline solution, and 0.5 ml of this preparation was injected into the body cavity of a mouse weighing 12 - 13 grams. The toxicity was judged by whether or not the animal was alive at the end of 48 hours. The following table shows the results:

Species of Fish	kuchiku		moray		balloonfish	
No. of Strain	1	6	9	10	13	14
Platinum Wire						
1	weak (large)	weak (small)	weak (large)	died	died	weak (large)
$\frac{1}{2}$	weak (small)	lived	lived	weak (small)	weak (small)	lived
$\frac{1}{5}$	all lived					
$\frac{1}{10}$	all lived					
$\frac{1}{20}$	all lived					

This means that mice died of the effects of the amount of bacteria picked up on one platinum wire. There was no detectable difference in the virulence of the various species.

5. Chemical Studies of the Poison

It was unfortunately impossible to obtain the results desired in the important chemical researches because of insufficient help in dissecting and handling the specimens, an insufficiency of instruments and vessels, and the lack of refrigeration.

Fish obtained by the method described above were dissected and the muscle tissue, liver, gonads, and blood were put into separate vessels. Each organ and the muscle tissue were ground up finely in a milk-bowl, three parts of pure water were added, the blood was collected in a sterile test tube, chloroform and toluol were added to prevent decomposition, and the specimens were stored in a dark cool place until they were brought back to Japan. It is not known whether or not this method of preservation was a suitable one. Because of the method by which the fish were taken, they quickly died and their blood coagulated. Consequently only a very small amount of blood could be collected.

Experiments with this material were begun immediately upon my return to the Institute, but a period of at least two weeks had passed since the collection of the test materials. Although these were stored at low temperatures, on the way home the vessel encountered a typhoon and as a result the refrigeration equipment did not function perfectly. Also I was unfortunately not able to bring back a large amount of material because of the danger of breakage to glass containers aboard ship and because of the necessity of selecting only as much as was convenient to carry back with me. I also brought back specimens of crabs, coral, and sea-weeds.

I first filtered the test materials, removed the chloroform and toluol, and then injected 0.5 ml of the fluid into the body cavity of a mouse weighing 13-15 grams. The results were observed with controls (edible fish) for comparison. There were no effects and none of the animals died. Even when the test material was concentrated at a low pressure and injected into the body cavities of mice, no effects could be observed. I wonder whether this may have been entirely due to the unsuitable manner in which I transported the test materials? And in the case of a study carried on in a tropical area and requiring a considerable period of time, is it not senseless not to perform the experiments in the field?

6. Effect of the Occurrence of Poisonous Fishes on Fisheries in General and Countermeasures to be Taken

The principal fisheries of the South Sea Islands are those for the skipjack and the tuna. The question of whether the poisonous fishes are shore species or deepsea species has a direct and important bearing on the main fisheries of the South Seas. The poisonous fishes are mostly large species which occur outside of the reefs, but at least at present there have been no reports of cases of poisoning caused by skipjack and tuna (when eaten as raw fish). In general the consumers of these fishes hold the belief that they are never poisonous, and so there is no particular problem, however, if someone should on some occasion feel somewhat unwell for some other reason and this condition should coincide with his having eaten some skipjack or tuna, the report that these fishes are also poisonous would spread rapidly through the

Islands. An incident of this sort could reduce the South Seas fishery, with its vast and limitless resources, overnight from the flourishing condition to which it has been built by past endeavors to complete destruction. It would require a many times greater effort to recover from such a situation than it did to build up the industry in the first place.

In actual fishing poisonous fishes are always taken in large numbers along with the useful fishes. Since the poisonous fishes are completely lacking in commercial value, they are released again. This has the effect of protecting the poisonous fishes and gives them a greater power of propagation in comparison with the useful fishes, the ultimate effect of which will be to enable them to drive out the useful species. Particularly in the case of fishes like the akamasu, when they are taken in great numbers, the large fish, which are over 2 feet in length, often damage the nets. Furthermore these fish are voracious and they eat useful fishes, thus causing great damage. When a fish like the akamasu, which is highly valued at other islands, is treated as a poisonous fish the economic effects are great. Countermeasures against this situation might be to catch these fish at a certain season, say before the spawning season, and thus almost stop their propagation, or if their toxicity originates in their food, they might be held in ponds for a certain period of time until the toxicity was lost and in such a fashion poisonous fishes could be made nonpoisonous.

7. Conclusions

The following conclusions can be drawn from this study:
(1) Large fishes which inhabit the waters beyond the reefs are likely to be poisonous. It is thought that the toxicity may be peculiar to fully matured fish or that it may be related to the gonads. It may be that because of the water temperature (surface temperature 27 - 28°) these fish contain ripe eggs more often than do fish in Japanese waters and that therefore they can produce poisoning at any time. Since the same species may or may not be toxic at different islands or even at different places within the same reef, it may perhaps come down to a question of a particular type of food found only in particular places.
(2) Since people differ individually in their physical makeup, it may be that in some cases where poisoning was caused by something else the story was passed along that a certain fish was toxic.
(3) It is also thought possible that some of these poisonings may be ptomaine poisoning. In this area the fish peddlers carry their wares on their heads in boxes (about 3 feet long by 2 feet wide by 6 inches deep) with 2 to 4-inch squares of wire screen in each side (for ventilation). The fish in the shops are so covered with flies that it is hard to tell what species they are. Ice is never put on the fish as it is in Japan and consequently the fish are dried out, the color of the skin is faded, the elasticity of the muscles is lost, and the fish looks almost as if it had been exposed directly to the rays of the burning sun. Under such circumstances the protein of the flesh is decomposed and one feels deeply that eating such fish may give rise to so-called ptomaine poisoning.

In making this study I took the reports of fishermen as a foundation. I am very much ashamed of the fact that I was unable fully to carry out the task assigned me because of the short duration of my stay in the field and the continuous unfavorable weather.

As for the character of the toxic element, at present we are limited to the conjectures set forth above, and our knowledge on the subject is extremely

vague. We must not stop our work until the following have been accomplished:

1. Investigation of the spawning seasons of poisonous fishes
2. Investigation of the food of poisonous fishes
3. Animal feeding tests with each of the organs of raw poisonous fishes
4. Tests on experimental animals with poison from the various organs of poisonous fishes without using chemical techniques
5. Serological studies of poisonous fishes

Such studies should reveal where the toxic element is located and its relation to the gonads and to the food habits of the fish. Once this has been accomplished, if the toxin is sought by chemical techniques, it will be possible to clarify its pharmacological significance and it will not be difficult to find its clinical applications.

The essential point is that the work should be done in the field with fresh material to ascertain the presence of poison by means of experiments on animals.

These investigations are truly difficult and they will not, of course, be accomplished in a day, but on the other hand I believe that they are important problems which should be clarified.

It appears that in China and Japan, where balloonfish are used as food, the fact that the balloonfish is poisonous has been known since very ancient times. In the Shan Hai Ching written by Po Yi, Minister to Ti Shun, it is noted that "eating this kills people". In 1645 Shigeyori Matsue published his Mokyūsō in which is found the famous old saying "I would like to eat the balloonfish, but my life is precious to me." There are many other notes on balloonfish poison in ancient books, and in quite a few instances the writers even made more detailed reports to the effect that the poison was contained in the liver and the gonads. These, however, were all mere records of experience and there was not one person who sought the balloonfish poison scientifically. The study by Matsubara (1883)[1] is regarded as the first attempt at a scientific handling of this matter. He fed balloonfish ovaries to dogs, injected fluids from the ovaries, and ascertained that these methods produced symptoms of poisoning. Later there was a continuous series of reports by Takahashi and Inoko (1889, 1892, 1893)[2,3,4], Ishihara (1917, 1924)[5,6], and Yano (1937)[7], all of whom made pharmacological studies of the toxic action of balloonfish poison, by Tahara (1894, 1909, 1910, 1912)[8,9,10,11] and Kaneyama (1943)[12], who made detailed studies of the chemistry of the poison, and by Tani (1940, 1945)[13], a pupil of Professor Fukuda of Kyūshū University, who made detailed studies on the toxicity of various organs of all species of balloonfish at various seasons. Since the author has already (1947)[14] discussed the results of all of these studies in an earlier article, they will be omitted here.

Among this great abundance of reports is that of Ishihara (1917)[5], who administered balloonfish poison to various animals and investigated their reactions and particularly the lethal dosage. The present author has, however, experimented with the poison on an even greater number of animals from the human at the top taxonomic level down to the lowly protozoans -- accepting the results reported by other researchers for those animals such as the human and the rabbit on which he was not able to experiment himself -- and he has reached some interesting conclusions which are reported herein.

Materials and Methods

As a source of balloonfish poison the entrails of the komon fugu [Sphaeroides alboplumbeus (Richardson)] were fed to animals, and a 0.01% solution of Sankyō's Tetrodotoxin (T) or a solution extracted by Tahara's method from the viscera of S. alboplumbeus were employed. These solutions were injected subcutaneously into vertebrates and were injected or dropped into suitable places such as the body cavity in ascidians, the mouth, eye, or legs of insects and crustaceans, the body cavity or gills of mollusks, and the body cavity of echinoderms and coelenterates, and their reactions were observed.

As is shown in the tables, these experiments were performed upon a large number of species of experimental animals. The heading "reaction time" means the length of time required before any reaction to the balloonfish poison was exhibited. For example with the tonosamagaeru [Rana nigromaculata Hallowell] it is the period of time from directly after the injection until the frog began to roll its eyes and to breathe in a fashion resembling the Cheyne-Stokes respiration. The "lethal time" is the period until respiration and all movement cease. A peculiarity of balloonfish poison, however, is that even after respiration ceases the heart continues to beat.

*A continuation of work done at the Tokyo University Natural Science Laboratory

Results of the Experiments

As the table shows, balloonfish poison is fatal (by paralysis of the central nervous system) to all kinds of animals below the human level. The balloonfish is not, however, affected by the poison of other members of its family (the Tetrodontidae), although one kind of poisonous spider, the koganegumo [Argiope sp.] is harmed by this poison. When a solution of balloonfish poison was poured into a shell inhabited by a hermit crab, the crab came out of the shell. When the poison was injected into their chelipeds, some ishigani [Charybdis 6-dentata Herbst] spontaneously cast off these appendages. The poison had, however, already circulated in their bodies and they died. As the result of a very carefully performed experiment an octopus was affected by balloonfish poison and died. But an extremely noteworthy point is that although mollusks other than the octopus and other animals of lower levels of development showed more or less reaction to the poison - for example snails were paralyzed for fairly long periods of time by large injections of poison - none of them ever died of its effects.

Why is it that the balloonfish and the other lower animals with the exception of the octopus are immune to balloonfish poison? Do the balloonfish, like other poisonous animals such as the poisonous snakes, have antitoxins to their own poison? Is it perhaps that these lower animals lack the type of nervous system which could be affected by the poison? The answers to these questions will probably have to await further study. Finally I wish to report one fact and that is that balloonfish poison does not pass along the nerves but is spread throughout the body in the blood vessels. The author ascertained this fact by the experiment of tying a string around the proximal portion of the hind leg of a frog [R. nigromaculata] so that pressure was applied only to the blood vessels, injecting the poison near the distal end of the leg, and then untying the string after the passage of a definite period of time.

In closing I wish to express my thanks to Professor Tsuyoshi Inoue of Kanazawa Medical College for facilitating this study in various ways.

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Animal	Date Collected	Number of Individuals	Average Body Weight	Amount Injected	Reaction Time	Lethal Time	Remarks
man	The lethal quantity is about 2,000,000 mouse-units (the weight in grams of a French mouse which can be killed by 1 gram of balloonfish viscera)						Tani (1945)
domestic rabbit	The lethal dose is 2.5 mg per 1 kg of body weight........						Yano (1937)
mice	0.06 mg per 10 g of body weight........						Yano (1937)
"	6-29-43	5	(14.5;)	Fed the liver and ovaries of <u>Sphaeroides alboplumbeus</u>, they died violently.			
guinea pig	1 cc of a 0.1 - 0.15 % solution is lethal						Ishihara (1917)
dog	25 mg per 1 kg of body weight						Yoshizawa (1890)
puppy	5-5-43	1	923 g	T 4 cc	?	32 min	no vomiting
cat	1 cc of a 0.1 - 0.15 % solution is lethal						Ishihara (1917)
kitten	4-10-43	1	Subcutaneous injection of fluid from viscera of <u>Sphaeroides alboplumbeus</u> produced repeated vomiting and death.				
chicken	0.6 cc of a 0.1 - 0.15 % solution is lethal						Ishihara (1917)
pigeon	0.27 cc of a similar solution is lethal						Ishihara (1917)
swallow	0.4 cc of a similar solution is lethal						Ishihara (1917)
"	9-13-1946	1	24.5 g	T 0.25 cc	2 min	4 min	After 2 min the eyes closed; after 3:30 min the beak was opened and the bird was in agony.
"	9-13-46	1	21.0 g	T 0.1 cc	3 min	3:10 min	After 2 min the beak was open and the bird was in agony.

snake (Elaphe climacophora)	8-12-43	1	about 105 cm long	T 1 cc	? greatly weakened after injection	? ran away	Ishihara (1917) reported the large figure of 45 cc as the lethal quantity for the yamahebi [Natrix tigrina?]
Bufo vulgaris japonicus	Ishihara (1917) reported the lethal quantity to be as much as 20 cc.						
Rana nigromaculata	0.08 mg per 10 g of body weight....................................						Yano (1937)
"	1943 - 1946	135	approx. 10 g	Found to be T 0.08 cc per 10 g of body weight.			
Squalus suckleyi	1-25-45	1	?	T 1 cc	1-2 min	approx. 30 min	The test was made with the fish hanging in the water on a line.
loach	9-26-45	3	(10.5 g)	T 0.1 - 0.2 cc	immediate	6-4 min	At first the fish rolled over, then was still, then had convulsions, and finally lay on its side.
carp	0.2 cc of a 0.1 - 0.15 % solution was lethal						Ishihara (1917)
Carassius auratus	9-7-44	4	8.0-12 g	T 0.1, 0.2	immediate	5-10 min	Rushed about madly and died.
eel	8 cc of a 0.1-0.15 % solution is lethal....................................						Ishihara (1917)
"	I made rather detailed experiments with eels from the Hamana Lagoon and found that the lethal quantity for these animals is rather large.						
Tylosurus giganteus	9-46	1	17.5 g	T 0.05 cc	40 sec	1:30 min	Opened its beak and writhed

Lateolabrax japonicus	4-8-45	1	37 g	T 0.1 cc	——	3 min	
Sparus macrocephalus	3-6-45	1	20.5 cm	T 0.2 cc	immedi-ate	4:40 min	Immediately after injection the fish swam madly around in the tank and then lay on its side.
Sillago sihama	7-20-45	1	18.7 cm	T 0.1 cc	"	approx. 2 min	
Rudarius ercodes	8-2-46	1	6.5 g	T 0.1 cc	——	5 min	writhed slightly
Spheroides vermicularis	Absolutely no reaction to balloonfish poison .... Takahashi and Inoko (1893)						
Spheroides stictonotus	" " " " " " " " " "						
Spheroides chrysops	" " " " " " " " " "						
Spheroides porphyreus	8-45	1	115 g	T 1 cc	No poisoning or deaths resulted.		Immediately after injection the fish were slightly agitated, but they soon reverted to their normal state.
Spheroides alboplumbeus	8-43 9-45	4	(97 g)	T 0.5-1.5 cc			
flounder	0.05 cc of a 0.1-0.15 % solution is a lethal quantity .... Ishihara (1917)						
Acanthogobius flavimanus	8-45	6	approx. 20 g	T 0.05-0.1 cc	immediate with 0.2 cc or more	within 25 min	Pumped water through the gills and swam about wildly.
Chasmichthys dolichognathus gulosus	8-3-46	6	(18.0 g)	T 0.05-0.1 cc	immedi-ate	20-30 min	Those which reacted pumped water strongly through their gills and swam about wildly.

Enedrias nebulosus	9-17-45	1	42.2 g	T 0.1 cc	15 sec	9 min	Curled up its body like a snake and writhed.
Blennius yatabei	8-2-46	1	10.3 g	T 0.1 cc	immediate	3 min	Curled up its body like a snake immediately after the injection.
Styela plicata [an ascidian]	9-11-46	2	7.1, 5.0 cm long	T 0.1 cc	?	?	After the injection the animals were suspended in the sea. They were decomposed at the end of 2 days. (The control survived.)
Polistes hebraeus	6-27-45	1	2.5 g	T 0.2 cc	——	10 min	Injected 0.1 at first, but no effect so added 0.1 cc.
Stratiomyia barca	8-28-46	1	0.5 g	T 1 drop	after several minutes	about 5 min	
Ptecticus illucens	8-26-46	1	0.2 g	T 1 drop	instantaneous	instantaneous	Injected into the eyeball
Stauropus fagi persimilis	8-26-46	1	3.7 g	"	——	12 min	Injected near the mouth
Anax parthenope julius	8-25-46	1	1.5 g	"	immediate	12 min	T was dropped into the mouth.
dragonfly	The lethal quantity is 0.13 cc of a 0.1-0.15 % solution........................						Ishihara (1917)
Oxya japonica	8-29-46	1	0.8 g	T 1 drop	30 sec	22 min	Injected with a needle into the thin part of the third leg.

Atractomorpha bedeli	8-29-46	2	(2.2 g)	T 1 drop	approx. the same	approx. the same	Peculiar convulsions of the third leg
Pachytilus danicus	9-12-46	3	(4.5 g)	T 0.5 cc	30-40 sec	7 min	Almost no signs of suffering
Argiope amoena	8-21-46	1	0.7	T 0.1 cc	immediate	immediate	Injected near the heart; died as if sleeping
Penaeopsis monoceros	7-2-43	2	29.5 g 31.0 g	T 0.2 cc	immediate	2 min 3 min	Dashed wildly about in the water.
Leander serrifer	8-4-46	1	5.9 g	T 0.25 cc	immediate	1 min, 10 sec	Injected into ventral part of 2nd ventral segment; body contorted, swimming legs convulsed.
Eupagurus japonicus	9-25-46	1	3.5 g	T 0.2 cc	in 30 sec was trying to get out of shell	20 min	Dropped inside of the shell
Eupagurus japonicus	9-25-46	1	0.5 g	T 0.05 cc	immediate	30 sec	Injected into the part protruding from the shell.
"	8-2-46	3	(1.1 g)	T 0.05 cc	"	1 - 2 min	"
"	"	1	0.5 g	T 0.1 cc	30 sec	40 sec	When the solution was dropped into the shell, the crab came out.
kakubenkei [grapsoid crab]	8-2-46	1	6.0 g	T 1 drop	instantaneous	instantaneous	Injected in cheliped

Sesarma intermedius	9-26-46	1	7.5 g	T 1 drop	instantaneous	instantaneous	Injected in cheliped
Sesarma haematocheir [?]	9-10-46	1	12 g	T 0.05 cc	"	10 min	Same as above. The crabs did not run around but only exhibited stiffening and convulsions.
Charybdis 6-dentata	9-17-46	2	(48 g)	T 0.05 cc	"	approx. 4 min	Same as above. One crab shed its cheliped immediately after injection.
Polypus ocellatus	10-16-45	2	23 g 47 g	T 0.3 cc T 0.5 cc	immediately?	32 min 40 min	Number of respirations after injection were 22 and 35 respectively. Upon dying the bodies turned white.
"	10-20-45	2	25 g 26 g	T 0.5 cc	"	approx. 30 min	Experiment performed in a live-pen in the sea. Left for 1 day after death.
Polypus ocellatus	10-25-45	2	25 g 30 g	T 0.4 cc	immediate?	approx. 30 min	The control in the live-pen did not die.
Ostrea gigas	1-14-43	2	61.5 g 54.5 g	T 0.1 cc	?	——	After injection the oysters excreted mucus, but none of them died.
"	"	2	67.5 g 53.0 g	T 0.5 cc	?	——	
kodamagai [a clam]	5-27-43	4	(4.22 g)	T 0.5-1.0 cc	?	——	Excreted a little mucus after injection; observed for 24 hours

Meretrix meretrix	7-3-46	3	(36.5 g)	T 0.25-0.5 cc	Still as if dead for several hours	—	Excreted mucus.
Tegula argyrostoma basilirata	11-4-45	10	(2.9 g)	"	"	—	Some excreted mucus, but not one died.
Rapana thomasiana	8-2-46	2	20.5 g 6.6 g	T 1.0 cc T 0.25 cc	"	—	Excreted mucus
Fusinus perplexus	11-4-45	5	(4.1 g)	T 0.5 cc	"	—	" "
Meghimatium bilineatum	9-15-42	2	1.0 g 0.8 g	T 0.25 cc	Still as death for about 12 hours	—	After injection excreted mucus and lost power of adhesion
Eulota lubuana	8-2-46	1	6.2 g	T 0.6 cc	Immediately lost power of adhesion, horns contracted	—	Moved again after about 20 hours
Marphysa iwamusi	2-26-44	2	0.55 g 0.32 g	Placed in 2 cc of T	Suspended animation in 6 and 4 min. respectively	—	Taken from the solution and placed in pure water, they became lively in 2 hrs.
Perichaeta communissima	10-42	1	—	Placed in 1 cc of T	Suspended animation in a few minutes	—	Ran away

Whitmania pigma	9-26-46	1	0.8 g	T 0.2 cc	immediately	—	Twisted its body in a circle, but recovered in 30 minutes.
Asterina pectinifera	2-26-44	2	8 g total	T 0.2 cc T 0.5 cc	Suspended animation for quite a long time.	—	Injected in the mouth region; tube feet immediately contracted.
sea-urchin	9-11-46	1	1.4 g 2.7 g	T 0.2 cc T 0.1 cc	"	—	Immediately after injection spines stopped moving; placed in live-pan.
Stichopus japonicus	2-26-44	1	7.0 g	Soaked in 2 cc of T	Lively when returned to sea water	—	Stretched body, then contracted, remained still for 30 minutes, excreted mucus.
"	1-31-42	2	225.0 g 210.0 g	T 0.5 cc T 0.2 cc	"	—	Contracted body, opened and closed anus
"	"	1	80.5 g	T 1 cc	"	—	Opened anus intermittently
Cribrina artemisia	8-5-46	3	—	approx T 1 cc	immediate	—	Still all right one week later
urashima-kurage [a jellyfish]	9-2-46	1	length of umbrella 16 cm	T 0.5 cc	"	—	Recovered when replaced in sea water.

Cases of poisoning by the Reef Fish LUTJANUS VAIGIENSIS

While engaged in studies on the reef fishes of Okinawa Prefecture, I recorded a score or more of poisoning cases caused by akana (Lutjanus vaigiensis (Quoy and Gaimard). A few reports[2,3,4,5] of cases of humans being poisoned by this and related species in the South Seas have already been published. However, since poisoning cases are not yet known from this area, I wish to present this report. Touching upon the preparation of this manuscript, I would like to express my deep appreciation to Viscount Keizo Shibusawa, who aided in this study, and to my kind teacher, Dr. Yaichiro Okada, for his constant guidance and review. In addition, thanks are due to Isamu Nagai, B.M. (TN: Bachelor of Medicine) for his many suggestions, to Kiichi Sato, Department Head of the Okinawa Prefectural Higher Normal School, for making facilities available for this study, and to Technician Hirotaka Yashiro.

1. Description of the Species

The fish which causes poisoning is Lutjanus vaigiensis (Quoy and Gaimard) and is called akana and akasubi in this region. Describing a single male specimen, 335 millimeters in total length, caught at Kutakajima on July 3, 1942:

Akana: Lutjanus vaigiensis (Quoy and Gaimard)

Morphology: body length:body depth, 4 3/4; body length:head length, 2 3/5; head length:snout length, 2 2/5; head length:diameter of eye, 4 3/4; snout length:diameter of eye, 1 3/4. Body fusiform, dorsal profile somewhat arched. Eye placed high, snout conical with pointed tip. Gape somewhat slanted. Upper and lower jaw roughly of the same length, the end of the upper jaw reaching a point directly beneath the ventral margin of the eye. The posterior edge of the opercle projects. Dorsal fin, 10 spines, 14 soft rays; anal fin, 3 spines, 8 soft rays; 57 pored scales along the lateral line; dorsal spines and rays stiff; IV is longest dorsal spine; III is longest anal spine; pectoral fins long and falcate with slender tips reaching to the anus. Caudal fin broad, the posterior margin deeply split and bifurcate. The lateral line runs high along the body, following the dorsal profile; the scale rows dorsal to the lateral line run at an angle to the lateral line.

Coloration: Back and dorsal sides of body reddish-brown, abdominal sides of body rose-colored, abdomen white. Bluish-green parts beneath the eyes and posterior margin of the opercle tinged with brownish-green. Pectoral, dorsal, and caudal fins light reddish-brown in color, pelvic and anal fins grayish-red.

Notes: This description agrees with okifuedai, Lutjanus vaiegiensis (Quoy and Gaimard) of Okada and Matsubara[6]. Furthermore, it agrees with Miyama's[7] description of akadokutarumi, Lutjanus vaiegiensis (Quoy and Gaimard) reported from Saipan and Tinian. On the other hand, it differs from fish reported from Japan as okifuedai, Lutjanus vaiegiensis (Quoy and Gaimard) by Shigeho Tanaka in the shape of the body, the relative diameter of the eye, number of pored scales along the lateral line, the angle of the scale rows above the lateral line, relative length of the dorsal spines, relative length of the anal spines, the shape of the caudal fin, and coloration of the body. Since I was unable to consult Quoy and Gaimard's original description, I compared it with other descriptions and found that it agrees very well with H. W. Fowler's[10] Lutjanus vaigiensis (Quoy and Gaimard) reported from the Philippine Islands. Here, I have adopted Lutjanus vaiegiensis (Quoy and Gaimard) as the scientific name and without using either of the two Japanese names, have referred to this fish by its local name, akana.

2. Poisoning Cases

Species of poisonous fishes found in this region are extremely limited in number and because of the clear distinctions, there is no danger of confusing this species with other species. Although the body lengths of the fish used are not known, the body weights are recorded because they were determined by examining the quoted prices of the fish. All were large, mature fish weighing more than one kin (1.32 lb.) and less than 15 kin. One kin in this region is equivalent to 160 momme (.132 oz.) The amount of fish ingested is only that amount remembered by the person affected and is approximate. None of the patients were examined by doctors or treated with home remedies.

Example No. 1

Locality: Shimajiri-gun, Chinen-mura, Ōaza Yamazato
Date: March 20, 1934
Fishing ground: Depths between Chinen-mura and Kutakajima, arajinnū. Although the meaning of arajinnū is not clear, it probably refers to "deep waters".
Fishing method: One fish, 7 kin in weight, was caught by pole and line at about 10 fathoms (TN: one fathom equals 5 ft.)

Case No. 1

Naka--, Chi-- (TN: personal names deleted in part in original paper)	age 40	husband	farmer	large quantity of fish meat; three bowls of fish soup	poisoned

Case No. 2

Naka--, To--	age 40	wife		small amount of fish meat; two bowls of fish soup	no effects

Since sugar making had been completed on the date specified, Case No. 1 took leave of his household work, went fishing, and caught one akana. He immediately returned home and dressed the fish about 5 p.m. The bones, meat, and viscera were chopped up and the entire fish was used in making soup which was eaten about 7 p.m. From 10 p.m., fatigue was felt in the lower parts of the legs and this gradually extended to the upper body parts. About midnight, lassitude was felt over the entire body with sensory and locomotory impairment. Recovery started about 6 a.m. the following morning and after one day of rest, the patient was restored to health. Although the fish was prepared in the same way as for Case No. 1, Case No. 2 ate only a small amount of fish meat and fish soup. No effects were felt.

Example No. 2

Locality: Shimajiri-gun, Chinen-mura, Ōaza Shikiya
Date: June 10, 1942
Fishing ground: arajinnū
Fishing method: A drive-in net was used in about 10 fathoms of water at Kutakajima and at about 1 p.m. 78 fish were caught around a coral head.

Case No. 3

--yama,--non	age 40	husband	farmer	4 bowls of soup made with fish meat and viscera	poisoned

Case No. 4

--yama,--ko	age 29	wife		3 bowls "	"

Case No. 5

--yama,--shi	age 11	eldest daughter		3 bowls "	"

Case No. 6

--yama,--o	age 5	eldest son		1 bowl "	"

Case No. 7

--yama,--yoshi	age 8	nephew		2 bowls "	"

Because Case No. 3 had been informed by a fisherman in the neighborhood that the viscera is especially delicious, he made fish soup using a 15 kin fish without discarding the viscera. The soup was eaten about 8 p.m. He awoke at 4:30 a.m. the following morning because of a headache. Fatigue was felt in the legs and pain in the joints. The nerves of his arms and legs became paralyzed and movement was impaired. The following 30 minutes were spent in great pain. Afterwards, the pain gradually eased and by 7 a.m., suffering has practically ceased. Although the effects disappeared after three days in bed, two additional days were spent in rest because of a weakened condition. The symptoms felt by Case No. 4 were identical to those of Case No. 3, but no rest was required because the effects were light. Case No. 5 complained of a headache with apparent weariness of the arms and legs. Case No. 6 exhibited symptoms similar to seasickness. Although Case No. 7 complained of fatigue in the arms and legs, he left for school at 8 a.m. After going about 1000 metres from the house, his legs wouldn't move and not being able to walk, the boy started to cry. Fortunately, a man with a horsecart was passing by and he loaded the boy into the cart and brought him home. Although he was breathing feebly when brought home, he was able to attend school after three days in bed.

Case No. 8

--kawa,--zo	age 39	husband	part-time farmer and fisherman	4 bowls of soup made with fish meat	poisoned

Case No. 9

--kawa,--ki	age 41	wife		"	"

Fish soup was made with an 8 kin fish after discarding the viscera. The soup was partaken at supper at 6 p.m. At about 6 a.m. the following morning, Case No. 8 felt tired all over and at the same time, felt pain in the joints of his arms and legs. He states, however, that there was no need of resting

from work or for staying in bed. Case No. 9 had symptoms similar to those of Case No. 8 but being more severe, she rested in bed for three days. An additional three days of rest were spent thereafter.

Case No. 10

--nen, --yu	age 47	husband	part-time farmer and fisherman	1 serving of boiled fish, 1 serving of raw fish	poisoned

Case No. 11

--nen, --ko	age 47	wife		1 serving of raw fish	no effects

Case No. 12

--nen, --ko	age 19	eldest daughter		"	"

Case No. 13

--nen, --yo	age 11	second daughter		"	"

Case No. 14

--nen, --shi	age 2	third daughter		2 slices of raw fish	"

One fish weighing 12 kin was eaten during supper at 8 p.m. of the specified date. Case No. 10 ate boiled parts of the head, gills, and a part of the viscera, in addition to the raw fish. From 4 a.m. the following morning, he felt fatigue in the arms and legs. A day's rest was taken. After three days, the effects disappeared and he recovered on the 10th day.

Case No. 15

Ari--, Fuku--	age 28	husband	fisherman	3 servings of boiled fish meat	poisoned

The viscera of a 6 kin fish was discarded, and the meat alone was boiled and eaten at 7 p.m. Effects were felt from 5 a.m. the following morning, and these were practically identical to those of Case No. 10. Three days of rest were taken.

Case No. 16

Ari--, Kai--	age 26	husband	fisherman	2 servings of boiled fish meat	poisoned

A 6 kin fish was boiled and partaken for supper at 7 p.m. From 11 p.m. pain was felt in the vertebral joints and joints of the arms and legs. Suffering did not cease until noon the following day. Three days of rest were taken.

Case No. 17

--shiro,--ichi	age 70	grandfather	1 serving of raw fish, 3 bowls of soup made with fish meat	no effects

Case No. 18

--shiro,--rei	age 43	husband	"	"

Case No. 19

--shiro,--hisa	age 24	eldest son	"	"

Case No. 20

--shiro,--saku	age 15	second son	"	"

The viscera of a 12 kin fish was discarded and the meat alone was prepared at 6 p.m. and served at 8 p.m.

Case No. 21

Tama--,--toku	age 56	husband	part-time farmer and fisherman	1 serving of raw fish, 2 bowls of fish soup	no effects

Case No. 22

Tama--,--ye	age 55	wife		3 bowls of fish soup	"

Case No. 23

Tama--,--ko	age 22	eldest daughter		2 bowls of fish soup and meat	"

Case No. 24

Tama--,--ko	age 16	second daughter		2 bowls of fish soup	"
Case No. 25	age 6	third caughter		1 serving of raw fish, 2 bowls of soup	"

A 14 kin fish was prepared at 7 p.m. and served at 8 p.m. The fish eaten by the above-listed cases was hung in a cool, shady place from the time it was caught until it was dressed.

Case No. 26

Wata--, Yoshi--	age 35	husband	part-time fisherman and farmer	2 servings of boiled dried fish	no effects

Case No. 27

Wata--, Ka--	age 33	wife		2 servings of boiled dried fish	no effects

Case No. 28

Wata--, Ya--	age 8	eldest daughter		"	"

Case No. 29

Wata--, Mu--	age 6	second daughter		"	"

Case No. 30

Wata--, Ki--	age 4	third daughter		"	"

A 10 kin fish was used which, after removal of the viscera, had been dried in the hot sun for 5 days.

Case No. 31

Shin--, Ei--	age 58	husband	public official	2 servings of boiled dried fish	no effects

Case No. 32

Shin--, To--	age 54	wife		"	"

Case No. 33

Shin--, Masa--	age 29	eldest son		"	"

Two 8 kin fish which had been dried for 4 days in the sun after removal of the head, viscera, and bones were eaten for supper on the fifth day.

The 31 cases in Example 2 all used fish from the same catch. According to the fishermen, many fish of this species were mixed in with the day's catch. The fishermen, knowing this species to be poisonous separated them from the catch and instead of sending them to market, brought several home for use and distributed a share to the village. Those that ate the fish out of curiosity and daring suffered the described effects. Several residents of the same village who had received the fish escaped harm because they heeded the warnings of old men and threw away the fish.

Example No. 3

Locality: Shimajiri-gun, Zamami, Ōaza Zamami
Date: August 16, 1943
Fishing ground: 100 metres from the tip of Kurigakinoshima off Zakammi-gakya; water depth approximately 7 fathoms
Fishing method: One fish was caught by pole and line during high tide about 9 p.m.

Case No. 34

--hara, --ri	age 42	husband	public official	2 servings of raw fish	poisoned

Case No. 35

--hara,--ko	age 39	wife		1 serving of raw fish	no effects

Case No. 36

--hara,--yo	age 12	eldest daughter		"	"

Case No. 37

--hara,--ji	age 11	eldest son		"	"

Case No. 38

--hara,--shi	age 9	second daughter		"	"

Case No. 39

--hara,--taka	age 8	second son		"	"

The fish was brought home and prepared as raw fish the following morning at 6 a.m. and was eaten for breakfast at 7 a.m. Case No. 34 felt badly from noon as from seasickness and fatigue was gradually felt in the legs together with a headache and pain in the joints of the arms and legs. As a result, he went to bed. From 9 p.m., pain subsided and by the time he awoke at 5 a.m. the next morning, only a feeling of tiredness remained. He recovered after 2 days of rest.

3. Causes of Poisoning

Types of viscera causing poisoning:

	poisoned	no effects
Those serving fresh fish		
viscera	6	1
meat	6	18
Those serving dried fish		
meat	0	8

Although there was no great difference in the degree of poisoning caused by fish viscera and fish meat, there were a decidedly greatly number of poisoning cases resulting from the use of viscera from fresh fish. Twenty-five percent of the cases were from fish meat. There are as yet no cases of poisoning from dried fish meat.

Serving methods: The fish were not handled by special cooks but were all prepared at home. Fish were served raw, boiled, and as soup. Of these three, raw fish and boiled fish did not differ greatly in preparation from methods used locally, but the soup was prepared unlike ordinary soup. The method of preparation may be said to fall between that used for boiling fish and that

used for making soup. The meat alone is used with a small amount of liquid, and bean paste is usually added as a flavoring agent.

Percentage of poisoning cases according to method of preparation (fresh fish only):

	No. poisoned	No effects
Raw fish	2	15
Boiled fish	3	0
Soup	4	5

Although the proportion is as above, one case listed under raw fish cannot be said to have resulted from raw fish alone because both soup and raw fish were eaten at the same time.

Progress of poisoning: Headache 4-6 hours after ingestion; lassitude in the arms and legs followed by locomotory and sensory impairment; pain in the jjoints of the vertebrae and limbs. Improvement after 12-20 hours. Effects disappear after 2-3 days, leaving a feeling of tiredness. Recovery 2-5 days later. No vomiting or diarrhea. Symptoms differ in this respect with Yoshio Hiyama's report and puffer poisoning symptoms.[11] Since the village was an isolated one and did not have facilities for measuring body temperatures, I was unable to investigate fever formation. I have not yet been informed of any cases of death.

Addenda:

I. Tradition: According to local fishermen, the poison of this fish originates from two causes.

1. Only those fish which feed on bottom-dwelling, poisonous crabs, chingani, become poisonous. (However, no one has seen or caught any of these crabs)

2. Only those fish which feed on poisonous seaweed become poisonous. (No one has seen this poisonous seaweed)

Therefore, only those fish living in areas where poisonous crabs and seaweed are to be found are poisonous and the others are non-poisonous. Also, for this reason eating viscera will result in poisoning while eating the meat alone will have no effect. Furthermore, those fish inhabiting shallow places where the currents are weak are non-poisonous while those living in deep localities within swift currents are poisonous. Young fish are non-poisonous but mature fish which are lean and are colored red are poisonous. Although these statements have been made, they are hard to believe.

II. General observations: Since the foregoing poisoning cases number only 39 and the poison was not administered experimentally, I cannot draw any conclusions about these facts. If some observations are made with this data as a basis, they would be as follows:

The number of poison cases resulting from eating meat was less than 25 percent. However, practically all who ate viscera were poisoned. From this, it may be firmly established that the poison lies within the viscera. Furthermore, all poison cases from this species resulted from mature fish. If young fish are non-poisonous and mature fish are poisonous, as stated by fishermen, it may be that the fish become poisonous with the development of

the gonads. And, if fish caught in one locality are found to be extremely poisonous, it may be inferred that these are mature fish which have schooled for spawning with the spawning season, and that the poison has become virulent with the maturity of the gonads. Although these points cannot be immediately confirmed, these are interesting phenomena which suggest the truth. On the other hand, in regards to the cause of poisoning by the meat, was poison from the viscera included through careless preparation of the meat which was non-poisonous? Or does the meat contain a small amount of poison which, if taken in large amounts, shows symptoms of poisoning? Although it is not known which of these two possibilities are responsible, poisoning cases which have resulted from eating meat are as described. Moreover, there were no deaths among these patients, but several days of rest were required because of considerable suffering. Because of these points, to use this fish immediately as a source of food is dangerous and may result in reasonable harm. The future use of this fish will depend upon whether or not the various internal organs are poisonous. If only a part of the viscera is toxic, the meat can be utilized. If the meat is also poisonous, it may be possible to render the meat non-poisonous by determining the nature of the poison and applying this knowledge to developing special methods of preparation, such as drying the fish. In this way, this abundant and easily caught fish can be used as a source of food.

I am at present studying poisonous viscera and the composition of the poison, and plan to publish my results at a later date.

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On the structure of the poison spines of the Aigo (TEUTHIS (SYN. SIGANUS) FUSCESCENS)

The aigo belongs to the family Teuthidae, which according to Boulenger comprises only the one genus Teuthis in which thirty species are included. They are all herbivorous fishes which occur in the Indian Ocean and the Western Pacific. They are all warm water fish and are distributed from the temperate zone to the tropics. The aigo of Japan is distributed from the Tokyo area south. It is of course herbivorous and commonly feeds on brown algae. It occurs in shallow places where algae grow well. These fish are often seen feeding on algae in small groups of up to fourteen individuals.

Fishermen are very well acquainted with the fact that these fish have poisonous spines, and they never handle the fish with their bare hands because of their fear of the painful wounds caused by being stuck by them. Bottard was the first to reveal to the scientific world the presence of poison in this fish. He cited this fish along with a large number of other poisonous species. In recent years the Russian, Pawlowsky, has studied the anatomy and histology of many poisonous fishes, particularly of such Japanese members of the family Scorpaenidae as the okoze and kasago, various specimens of which were sent to him by Mr. Shigeho Tanaka of the Science Department. These studies have been published, but as he had no specimens of the aigo he did not study it. In my study of the poison gland of the aigo I have found that its construction closely resembles that shown by Pawlowsky for fishes of the family Scorpaenidae.

The poison of the aigo is in the stiff spines of the fins. The fin ray formula of the aigo is D. Xii or Xiii - 10, A. VII - 9, P. 16, V. I - 3 - I. This means that there are 12 or 13 spines in the dorsal fin, 7 in the anal, none in the pectorals, and two in each of the ventrals. These stiff spines are all equipped with poison glands. This being the case, because of the lack of spines in the pectoral fins the fish has these protective mechanisms only on the back and belly and is not equipped with any defenses toward attacks from the sides. In outward appearance most of the spines show an extremely sharp tip protruding from the fin membrane, but in some cases the first two or three spines of the dorsal, the spines of the ventrals, and the first one or two spines of the anal are occasionally completely hidden and covered with skin to their tips. Although the tips of the spines are originally naturally covered completely, for some reason, perhaps because the poison spines have once been used or because of contact with some foreign object, the soft skin has in some cases retreated, exposing the tips of the spines. Even when they are completely covered by the skin the tips of the spines are very sharp so that if they are touched they immediately come through the skin and pierce the object which touches them. A cross-section of one of the spines is shown in Figure 1. In the center there is the cross-section of the hard keratose spine (sp) with grooves in its right and left sides. These grooves lie longitudinally along both sides of the spine. These long concavities are occupied by the poison glands (pg). The poison glands are completely surrounded by connective tissue with a dermal and an epidermal layer on the outside. Under the epidermal layer are chromatophores (pgm) and in the epidermis are large single cells which are mucus glands (og). The connective tissue and the dermal and epidermal layers continue on to form the fin membrane (fin) and connect with the next spine. There is no muscular tissue visible around the spines.

With regard to the question of the length of the poison glands, in the aigo, as described above, they lie along the sides of the spines, and on all of them they disappear a short distance from the insertion of the spine. Consequently the length of the poison gland varies according to the length of the spine, the gland covering a rather long area on the longer spines. At the base

of each spine is attached a well-developed muscle for erecting the spine.

A detailed examination of the construction of the poison gland was made. The poison glands, situated as described above, are made up of only one homogeneous type of cells. Small protective cells can be recognized around the circumference of the gland but there are none to be seen between the cells of the gland. The glandular cells are much larger than those around the outside of the gland, some of them having a long axis of 26 microns and a short axis of 6 microns. The long axes of the cells are parallel to each other and lie at right angles to the body of the spine. As Figures 1, 2, and 4 show, in most cases each cell (pg) extends from one side to the other of the body of the gland. This extension of the cells completely across the body of the gland is not seen in the poison glands of other fishes such as <u>Trachinus</u> and the <u>okoze</u> and <u>kasago</u>, <u>Synanceia</u>, <u>Scorpaena</u>, <u>Pterois</u>, <u>Pelor</u>, <u>Sebastodes</u>, and so forth. The poison glands of these fish as described by Pawlowsky closely resemble in other points of their structure those of the <u>aigo</u> which I have studied, but they differ in having smaller glandular cells which are all supported by supporting cells (<u>Stützzellen</u>).

A consideration of the individual cells of the glands shows that their nuclei (n) (Figures 2, 3, and 4) are very small in proportion to the bodies of the cells. As is usual with the nuclei of glandular cells, their protoplasm is coarser in texture than that of other types of tissue and therefore their color absorptive power is weak, staining only slightly with hematoxylin.

The protoplasm is abundant and presents a densely granular appearance. It is extraordinarily eosin-positive and stains a bright red with this dye. It should be noted here that there are occasionally present within the protoplasm large round globules of nonstructural character. These are also eosin-positive and appear to be a colloid which is quite viscous. Even after paraffin embedding, staining, and washing with water they maintain their outline clearly. I interpret these as drops of poison. An examination of the cells of the gland also reveals the presence of a comparatively large number of vacuoles in the protoplasm. These vacuoles are rather numerous in some cases and comparatively few in others. Figure 3 shows an example in which they are comparatively numerous. The significance of these vacuoles is not clear, but it cannot be thought that they existed as vacuoles at the time when the fish was fresh. They must have been filled with some fluid which was lost during the microtechnique process and which is thought to have probably been related to the poisonous secretion. Similar vacuoles also appear abundantly around the periphery of the globules.

The body of the gland is as described above, but if we consider the question of whether or not there is a secretory duct attached to the gland, we must say that there is nothing which resembles such a duct. The body of the gland is made up of completely homogeneous cells, and even if we assume that the secretion which fills the space between the longitudinal grooves of the spine and the connective tissue issues into the inner part of the spine, there is no sort of a structure provided to conduct it to the outer part of the tip of the spine. Furthermore, since there is no muscle tissue around the spine there is no mechanism for compressing the body of the gland internally. With the body of the gland limited to the location described above, what one would like to know is how the <u>aigo</u> makes any use of the poison which it stores up.

An attempt was made to examine a living <u>aigo</u>. When held for inspection the fish appeared to be frightened and spread all of its fins so that the

spines all stood up stiffly. Thus the spines presented a condition such that anything which touched them would easily impale itself on them. If at such times the spines were touched with a piece of cloth or a cork, the spines immediately pierced the material and the fin membrane covering the spines was seen to tear very easily. Ordinarily aigo which are brought in by fishermen have the fin membranes all torn to shreds. This shows that while the fisherman was handling the fish something came in contact with the spines from time to time. The ease with which this skin tears is highly significant. When the spines pierce something, the membrane tears simultaneously, the poison gland is also ruptured, and its poisonous contents for the first time obtain passage to the outside to be transmitted along the concavities of the spine and injected into the wound. This is the only possible method for the spine to fulfill its function where there are no muscles to apply pressure, no ducts to convey the secretion, and no grooves to conduct it.

Figure 4 shows a cross-section of a spine the skin of which has been torn. The part where the body of the spine and the gland join is ruptured and it can be clearly seen how the cells of the gland release their contents from this portion. It can also be seen that the glandular cells near this ruptured portion contain a comparatively large number of globules. It is clear that with the rupture of the cells these too find their way out and are injected into the wound caused by the spine. To sum up, the poison of the aigo is injected passively by the tearing of the skin and the rupture of the poison gland when the spines pierce some object. Pawlowsky made no mention of this method of injection, but the poison glands of the fishes which he studied, all of which are listed below, were of the same general category which he called Drüsen von der kompakten, mehrzelligen. I would like to place the poison glands of the aigo in this category. The species whose poison glands belong to this type are as follows:

Family Scorpaenidae

daruma okoze	Synanceia erosa	Pawlowsky
oni okoze	Palor japonicum	"
mino kasago	Pterois lunulata	"
(kasago)	Scorpaena porcus	"
fusa kasago	S. fimbriata	"
(mebaru)	Sebastes norwegicus	
takenoko mebaru	Sebastodes joyneri	"
kasago	Sebasticus marmoratus	"

Family Trachinidae

(hatahata)	Trachinus draco	"

Family Teuthidae

aigo	Teuthis fuscescens	Amemiya

Family Siluridae

(gonzui namazu)	Schibeodes
(gonzui namazu)	Noturus

Of course these are not the only fishes which have poison spines. The Japanese names given are taken from Tanaka's paper in the Proceedings of the College of Science, and in the preparation of this manuscript Mr. Shigeho Tanaka assisted the writer by the loan of valuable source material and by checking the nomenclature used. Thanks are hereby expressed for these kindnesses.

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Description of Figures

Figure 1 Cross-section of a fin spine X60

Figure 2 Poison gland cut at right angles to the long axis of the cells of the gland X350

Figure 3 Cross-section of poison gland X350

Figure 4 Longitudinal section of fin spine showing how the poison issue from the ruptured tissues at the tip

cg	mucus gland cells in the skin
cnt	connective tissue
dp	where poison has flowed out of the ruptured gland
gb	poison globules
n	nucleus
pg	poison gland cells
pgm	pigment cells
sp	spine
v	vacuoles